Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 186 (2015) 388 – 394

Procedia
Social and Behavioral Sciences

5th World Conference on Learning, Teaching and Educational Leadership, WCLTA 2014

Educational Innovation in the Computer Architecture area

Jose Manuel Lopez-Guede [a]*, Ismael Soto[b], Aitor Moreno Fdez. de Leceta[c], Jesus Maria Larrañaga[d]

[a] *Systems Engineering and Automatic Control Dept, University College of Engineering of Vitoria, Basque Country University (UPV/EHU), C/Nieves Cano 12, 01006 Vitoria-Gasteiz, Spain*
[b] *Electric Enginering Dept., Santiago de Chile University, Av. Ecuador 3519, 9170124 Santiago, Chile*
[c] *Ibermática, Leonardo Da Vinci 9, 01510 Miñano , Spain*
[d] *Business Management Dept., University College of Engineering of Vitoria, Basque Country University (UPV/EHU), C/Nieves Cano 12, 01006 Vitoria, Spain*

Abstract

In the present work authors give a detailed description of the previously performed analysis carried out to formulate a concrete educational innovation project proposal in the area of the Computer Architecture, more specifically, in the Computer Structure and Architecture sub-module. That project was submitted to the competitive Educational Innovation Projects Call 2013-2015 of the Basque Country University (UPV/EHU, Spain), and fortunately, it was elected and granted by the Education Advisory Service of the same university. This project follows the the way started by another similar project but in other knowledge area of Electronics in the same University College. In this paper, the specific problems of the Computer Structure and Architecture sub-module in the University College of Vitoria-Gasteiz (that is the place where it is being carried out) are analyzed, the framework in a wide sense is described (University, University College and syllabus) and the specificities of the current project are explained. All the analysis is done taking into account the competences point of view (both specific for each subject and transversal for the degree).

Peer-review under responsibility of Academic World Education and Research Center

Keywords: Active Learning, Cooperative Learning, Computer Engineering, Computer Architecture;

1. Introduction

Active Learning is a wide paradigm that groups several methods, and it is based on the responsibility and involvement of the students in its own learning process (Bonwell & Eison, 1991; Felder & Brent, 1994). One of

* Jose Manuel Lopez-Guede. Tel.: +34-945-014-084
E-mail address: jm.lopez@ehu.es

Peer-review under responsibility of Academic World Education and Research Center
doi:10.1016/j.sbspro.2015.04.094

these methods is named Cooperative Learning, that is a paradigm in which the learning activities are planned looking for the positive interdependence between the participants of such learning (Felder & Brent, 2001; Felder & Brent, 2009) .

In this paper authors describe an Educational Innovative Project based on both active and cooperative learning, which is being carried out in the field of Computer Architecture. Its implementation is being carried out in the sub-module named Computer Structure and Architecture of the Bachelor Degree in Computer Management and Information Systems Engineering, of the University College of Engineering of Vitoria-Gasteiz, University of the Basque Country (UPV/EHU, Spain). With this implementation we are trying to overcome several difficulties that have been detected in the subjects of that sub-module.

The structure of the paper is as follows. The second section describes the specific problems of the Computer Structure and Architecture sub-module. The third section analyzes the framework in which the project is being carried out, analyzing the support given by the University of the Basque Country, the University College and the syllabus. The detailed characteristics of the project, its background and the expected results are shown in the fourth section. Finally, our conclusions and future work are described in the fifth and last section.

2. Specific problems of the Computer Structure and Architecture sub-module

In this section we are going to describe the specific problems that were found inside the Computer Structure and Architecture sub-module. As it will be explained deeply in section 3, this sub-module belongs to module "M02 – Module common to the Informatics branch", and it is composed of "Computer Structure" (first course, 6 ECTS) and "Computer Architecture" (second course, 6 ECTS) subjects. Without going into technical details, we can say without fear of deception that it is par excellence the sub-module dedicated to the hardware area of the degree.

Apart from other minor circumstances, we can classify the following ones as problematic:

- The students of Degree in Computer Management and Information Systems Engineering are students that basically seek software knowledge, not hardware, so their predisposition towards these subjects is not exactly optimal.

- Derived from this idea, they tend to have a confused view of the subjects that makes them believe that they are useless, at least immediately.

- When they start the engineering studies, students have some knowledge of mathematics, physics, chemistry, etc.; however, when they start this degree they do not have any hardware knowledge, so they have to start from absolute zero.

- The first subject of the sub-module is in the first course, when students do not have yet a habit of working according to what engineering is.

- On the other hand, the second subject belongs to the second course, still far from finishing their studies without a clear job position horizon, so they cannot see its utility.

- The courses are in sequence, and it is seemingly positive, but the reality is that in the first course there are a tiny number of students who go to the second course passing all subjects, so between the two subjects is usually more than one calendar year.

All these circumstances make it appropriate to provide a more dynamic and creative subjects that compose the sub-module, with the aim of maximizing the classroom attendance, the involvement in them and the acquisition of competences (both specific and transversal) established for the two subjects.

3. Global context

In order to solve the problems described above, we have launched an educational innovation project in a context and under some specific conditions. This framework will be explained in this section, specifying in different subsections aspects of the University as institution, the University College and the syllabus where it is being implemented.

3.1. Institutional framework: the University of the Basque Country

The project is being carried out at the University of the Basque Country, (UPV/EHU, Spain), financially supported by a grant obtained in the competitive Educational Innovation Project call 2013-2015 of the Education Advisory Service, Vicerectorship for Teaching Quality and Innovation. This vicerectorship is structured in four main areas:

- Quality Cathedra: Contributes to the knowledge, implementation and improvement of quality management in all areas of the organization of the university, helping to achieve the highest standards of excellence.

- Institutional Evaluation Service: A service of the university which aims to guide and promote the process of evaluation, verification and accreditation as well as those related to improving the quality of higher education. It also works with reference quality agencies in developing their programs in the university.

- Faculty Evaluation Service: A service dedicated to promote, design, develop, advise, facilitate and train faculty evaluation process with the desire to contribute to the improvement of teaching quality.

- Educational Advisory Service: It is a service which manages courses and training according to the needs of the faculty. It puts in place processes to gather information about which are the formation necessities.

All these areas converge towards a methodology named IKD-Ikasketa Kooperatibo eta Dinamikoa in Basque (Dynamic and Cooperative Teaching-Learning in English), characterized by the following principles:

- Active Education: IKD invites students to become the architects of their own learning and an active element in the governance of the university. To get this, it encourages learning through active methodologies, ensures continuous and formative evaluation, articulates the acknowledgement of its previous experience (academic, professional, vital and cultural), and promotes mobility programs (Erasmus, SENECA) and cooperation.

- Territorial and social development: The IKD model development requires an ongoing process through which the university is committed to its social environment and community, with public vocation and economic and social sustainability criteria, promoting values of equality and inclusion. It also takes into consideration peculiar characteristics of each of the three provinces where sits the university, to contribute to their empowerment and to extract from them their formative potential. A curricula development responsible with the social environment is done through internships, collaboration with social initiatives, social networks, the relationship with companies and mobility programs that promote international experience and cooperation of our students.

- Institutional Development: IKD curricula development drives institutional policies that promote cooperation between the agents involved in teaching, in an environment of confidence and dynamism. It promotes programs that encourage institutional structuring through the figures of the course or module coordinator, quality commissions and promoting teaching teams, which are key elements in this new teaching culture. Other institutional actions such as offering different types of education (part-time attendance, semi-face, non-face), significant and sustainable use of information and communication technologies (ICTs), institutional regulations concerning assessment, infrastructure design of educational institutions and public spaces (IKDguneak-IKDplaces), the extension of hours of use of space, should be considered from a perspective that encourages IKD culture.

- Professional development: First, the continuous training of the people involved in teaching activities (faculty and support staff to teaching), in order to promote adequate professional development. Training programs (ERAGIN, BEHATU, FOPU) project to support educational innovation (PIE) and assessment tools for teaching (DOCENTIAZ), among others, are actions that support the construction of IKD.

3.2. College framework: the University College of Engineering of Vitoria-Gasteiz

This experience is being developed in the University College of Engineering of Vitoria-Gasteiz (University of Basque Country, Spain). This University College has a long teaching career of over 50 years of existence, so it has known various curricula. The University College has a wide range of studies, and currently it has finished the Master degree in Industrial Engineering Organization and the following bachelor degrees: Technical Industrial Engineering, specialization in Industrial Electronics; Technical Industrial Engineering, specialization in Electricity; Technical Industrial Engineering, specialization in Mechanics; Technical Industrial Engineering, specialization in Industrial Chemistry; Technical Engineering in Topography and Technical Engineering in Computer Management.

At this time, after the adaptation to the European Higher Education Area (EHEA) the University College offers the Master in Production Organization and Industrial Management and the following bachelor degrees: Degree in Electrical Engineering, Degree in Industrial Electronics and Automatics; Degree in Geomatics and Topography, Degree in Mechanical Engineering, Degree in Chemical Engineering and Degree in Computer Science and Information Systems. It is in this last degree where our work is being framed.

3.3. *Syllabus*

The syllabus of the Degree in Computer Science and Information Systems from the University College of Engineering of Vitoria-Gasteiz is structured around five modules:

- M01 - Basic training module: The syllabus contains 60 ECTS of basic training materials related to the branch of Engineering and Architecture, which are divided into four sub-modules (Mathematics, Physics, Computing and Business). The aim is to ensure the achievement of basic competences.

- M02 - Common module to the Computing branch: They are subjects that cover skills that are nuclear and are covered by subjects which do not form part of the core cited above, but provide knowledge and general competences in the field of Computer Engineering, providing students a versatile and multi-disciplinary training. There are 66 ECTS for 11 subjects taught between first and third year, organized into six sub-modules. This module aims to ensure the achievement of the common competences to the computer branch.

- M03 - Information Systems module: The subjects comprising the module Information Systems (54 ECTS) provide training that, based on the competences acquired in basic and common modules to the computer training branch, explores aspects related to the organization, management and information systems. The nine subjects of the module are grouped into three sub-modules between 12 and 24 credits.

- M04 - Final Project module: The Final Project has 12 ECTS, and is required for graduation. The Final Project is an original work to be done individually. The project must be presented and defended with a university tribunal, and consists of a job in the field of Information Systems (specific Computer Engineering technology). In the development and presentation of the Final Project the skills acquired during the whole of the teachings are synthesized and integrated.

- M05 - Optional Module Training: Students have to study 240 credits. On one hand, 180 credits correspond to compulsory knowledge (Basic training module, Common module to the Computing branch and Information Systems module), and 12 credits to the Final Project module. The remaining 48 credits are the result of the free choice of the students. When choosing these 48 ECTS there are several options: training in companies (up to 24

ECTS); the development of cultural, sporting, charity or university activities (up to 6 ECTS); or take courses in the offer of optional titration.

4. Project design

This section will describe the specific design of the educational innovation project, analyzing in different subsections the previous experiences in similar projects, the specificities of this project and finally, the expected results.

4.1. Previous project experiences

In the working group created to carry out the project which is being described in this paper, there are faculties who have participated in a similar project. For example, one of the authors of this paper was the main investigator of the project named "Intra and Intergroup Cooperative Learning in Industrial Informatics Area". That project was selected to be executed in the biennium 2011-2013 in a competitive call of the Education Advisory Service of the University of the Basque Country (UPV/EHU). Besides the good results obtained from the academic and teaching point of view, the involvement of students came to the point that it could generate even two journal articles (Lopez-Guede, Fernandez-Gauna, Graña, Oterino & Larrañaga, 2012; Lopez-Guede, Fernandez-Gauna, Graña & Oterino, 2013) .

4.2. Specificities of the project

As noted above, in 2013 the Education Advisory Service of the Vicerectorship for Teaching Quality and Innovation published a competitive call asking for proposals related to active learning. Following the criterion of several faculties, this was a very interesting call for several reasons:

- It gave us the chance to experiment in the field of active learning with support of the university. This is a very important circumstance because if the results are not as good as is desirable, the participating faculties will not be exposed to actions by the institution at the end of the project.

- It gave us the opportunity to experience between faculties from different areas of knowledge, which we never could have interacted in any other case.

- We faced the possibility of achieving institutional recognition. This is an important factor because to participate in such kind of projects allows being included in other educational activities of the institution.

- It gave us the chance to enjoy a few hours of class exemption to prepare the project and design the set of activities that led to active learning.

- It gave us the opportunity to enjoy an endowment to renew the teaching materials and to disseminate the project itself in academic settings.

The authors of this paper, along with other teachers submitted a project proposal entitled "Intra and Intergroup Cooperative Learning in the Computer Structure and Architecture Sub-module", which was accepted to be developed in the biennium 2013-2015, a proposal that we explain below.

This proposal is developed over a biennium, which covers the two subjects sub-module, so its temporal development is from the second semester (beginning of the course of Computer Structure) of the course 2013/2014 through December 2015 (administrative finalization of the project). In short, this is a cyclical approach that is exercised twice for each subject, being the goal promotion (or to which more study will focus) that has taken the course of Computer Structure during 2014-2015 and Computer Architecture during 2015/2016. From that point on, all future promotions will use this methodology in the sub-module of Computer Structure and Architecture.

The basic operating mechanism is the working group, because as shown in the title of the project it is the support for cooperative learning, both within each working group and among different workgroups. The basic sequence of activities that are being carried out can be detailed as follows:

1. The first year of implementation, the educational innovation specialist of the team will advise the remaining faculties for each subject on the specific techniques to use, group size and variety of activities to prefer in terms of size. The range is dictated by the specific competencies to achieve, as well as some transversal ones. He will also advise on techniques to evaluate the performance of what has been launched.

2. Faculties directly related to the technical content of the subjects pose a series of learning activities looking for achieving specific and transversal competences.

3. At the beginning of each subject, the faculty of the Department of Business Organization member of the team will provide the students with basic techniques for maximum utilization of resources. He also will emphasize the techniques for conflict resolution.

4. Each subject will be developed according to the principles of cooperative learning, with the formation of groups and the production of deliverables by them. These deliverables will be written works with their corresponding oral presentations.

5. After the implementation in each subject, it will be subject to an external evaluation, understood as that carried out by another team member from another school, thereby obtaining valuable feedback.

6. Finally, note that throughout the whole process we will have the collaboration of two very young researchers, who will monitor the whole process.

Thus, apart from the specific competencies to each of the subjects, they are working the following generic skills:

- Written communication: to be worked by means of written works that will be assessed by teachers.
- Oral communication: it will be worked by means of presentations in class.
- Teamwork: to be worked along the subjects because they will be the basic mode of operation.
- Capacity for innovation and creativity: to be constantly worked at the time of designing both theoretical and practical works.
- Self study: it will also be worked steadily, at the same time that the previous two transversal competences.

4.3. Expected results

This subsection will describe the results that we expect to achieve based on our previous experiences, because the described project is still an ongoing work.

- Increased attendance at classes: With the implementation of such projects, the faculty has noted on previous experiences an increase in student attendance at classes. This usually comes motivated because the classes are not perceived as expositive ones, but they can interact because necessarily coincide with other students of the subject.
- Increased involvement and participation: Faculties often perceived an increased involvement and participation of students in the development of classes. Prior to implementation they used to show passive roles, but using the

paradigm of active learning, faculty goes to the background and students use time and space in an efficient manner.

- Better monitoring, tracking and evolution of each student: It has been shown that the use of collaborative tasks with deliverables by each working group can include in the schedule a number of evaluation points that evaluate the learning achieved, serving as breakpoints if a poor trend is detected. This implies corrective actions if necessary, including by the student.

- Better results in final tests: In the case of final tests, best results are expected due to ongoing work on the subject. Moreover, in other cases these final exams are not to be such a stressful experience because they have followed their own learning process.

5. Conclusions

In this paper we have presented an educational innovation project in the Computer Architecture area, or rather, in the sub-module of Computer Structure and Architecture, using the terminology of the syllabus of the Degree in Computer Management and Information Systems Engineering of the University College of Engineering of Vitoria-Gasteiz, where it is being carrying out. First we explained the specific problem of the sub-module, emphasizing the subjects that compose it. Next, we analyzed the framework (university, University College and syllabus) and the constraints derived for the adoption of a solution. Later we presented the educational innovation project as a tool to solve the situation, analyzing previous experiences and results to be achieved. As future work, it is obvious that the next step is to complete the implementation that is still being carried out, verifying the improvements that we are trying to achieve.

Acknowledgements

This research project on educational innovation is being financially supported by the grant 6719 of the competitive call for educational innovation projects 2013-2015 of the Educational Advisory Service, Vicerectorship for Teaching Quality and Innovation, University of the Basque Country (UPV/EHU), support that is greatly acknowledged. Authors also wish to thank the cooperative work done by students who kindly participated in the project (referred to above as previous experience) with the grant 6397 of the competitive Call for innovative educational projects at the same university in the 2011-2013 biennium (which was also supervised by the authors), as previous experience using cooperative learning techniques, since good results have served as a precursor and inspiration project whose design has been reported and is being implemented.

References

Bonwell, C. & Eison, J. (1991). Active Learning: Creating Excitement in the Classroom. *AEHE-ERIC Higher Education Report* No. 1. Washington, D.C.: Jossey-Bass.

Felder, R.M. & Brent, R. (1994). Cooperative Learning in Technical Courses: Procedures, Pitfalls, and Payoffs. ERIC Document Reproduction Service

Felder, R.M. & Brent, R. (2001). Effective Strategies for Cooperative Learning. J. *Cooperation & Collaboration in College Teaching, 10*(2), 69-75

Felder, R.M. & Brent, R. (2009). Active Learning: An Introduction. *ASQ Higher Education Brief, 2*(4)

Lopez-Guede, J. M., Fernandez-Gauna, B., Graña, M. & Oterino, F. (2013). On the influence of the prediction horizon in dynamic matrix control. *International Journal of Control Science and Engineering, 3*(1), 22-30.

Lopez-Guede, J. M., Fernandez-Gauna, B., Graña, M., Oterino, F. & Larrañaga J. M. (2012). Effect of the lambda parameter in dynamix matrix controllers performance. *Journal of Computer and Information Technology, 2*(2), 81-88.