

Higher/Secondary Education: a Successful Partnership

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Abstract - This paper describes a successful training to increase the motivation of the secondary students for the Engineering field. A collaborative project between a higher institution education and a secondary school in the north of Portugal is running. The specific goals of the project are: (i) to promote a more experimental collaborative teaching (ii) to develop the ability to technical and scientific research and innovation amongst the youth, (iii) to promote the interest and the motivation for technical areas among higher education applicants. The principal actors involved are: a group of students from the secondary school and two groups of teachers: from the secondary school and from the university institution. Each student develops his own project at the university laboratories, with a wide diversity of tasks according to the different phases of project. The projects run in automation, informatics and process simulation. The students, at the end of the project, make an oral presentation and a written report. From the point of view of the secondary students, this initiative is very innovative being the first contact with the university environment.

Key Words- Engineering Education, University/Secondary School Partnership.

MOTIVATION

The cooperation between universities and the cooperation between higher institutions and (local) industries, play a relevant role in the innovation and technology transfer. A different kind of cooperation is gaining special attention, namely the cooperation between institutions of different graduation levels: secondary schools and high schools. Many aspects can be pointed out to explain the interest under this collaboration. In particular, there is the exchange of students' population, the educational admission policies, the students' frequent lack of skill knowledge and most important the way of attract students for the engineering and technical areas. Nowadays, in general, these areas are suffering for a lack of students.

The University of Minho has a large know-how in collaboration with secondary schools. There is still quite a long history of this relationship. Several activities have been

already implemented, namely, university teachers' visits to secondary schools, teachers and students' visits from the secondary schools to the University campus. In both, the visits have a pre-defined program including talks or demonstrations related to each graduation course or some visits to Research Laboratories, respectively. Other initiatives have the support of the government, under the program *Ciência Viva* [1], as is the case of the recent *Roboparty Course* [2], focuses on attendees from eleven years old till eighty-eight. In this initiative, the attendees were welcome at the University to learn how to build and program mobile robots. There are also the *Holidays in the University*, *Summer University in Porto* [3], where students from ten to seventeen are invited to spend part of their holidays in the university campus, performing some interesting and entertain activities. It must also be pointed out the *open Week University* [4], where several initiatives take place in the university environments or in the public streets by performing open space demonstrative activities. These initiatives try to attract prospective students to all the university areas of study: from educational to engineering areas.

In parallel with this need for establishing a strong partnership with secondary schools, one can not forget the need for new teaching methodologies with students. Teacher should be a catalyst in the acquisition knowledge process, not a passive master that limits to enumerate a numberless of theories and concepts. The principal actor in the learning process should be, in fact, the student not the teacher. Cognitive theory states that knowledge learned and applied in a realistic problem solving context is expected to be remembered and used properly when needed later. In fact, these problem-based learning/teaching strategies, case methods and simulations, are useful tools for an effective teaching since students must become active participants rather than passive observers. Students must make decisions, solve problems and analyze the results achieved [5].

Following this idea, the use of the Internet as a vehicle of knowledge transmission becomes more demanding. The availability of the wireless in the university campus can help this increase, namely in student's level. The Internet appears as a convenient tool. Employing the technical means of programming in the Internet, teachers can expose the subjects in a structural way, animated, colored and always available for seeking. This web-assisted learning tool is

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regarded as a complementary learning. It consists of coupling the class teaching with the free teaching through the Internet, with animated case studies and interactive means, where students are active pieces in the learning process.

The experience described in this paper, illustrate a particular practice that involves an institution of High Education, School of Engineering of University of Minho (SEUM) and a Secondary Institution, Instituto Nun'Alvres (INA). The specific goals of this project are:

- Promote a more experimental collaborative teaching;
- Develop the ability to technical and scientific research and innovation amongst the youth;
- Promote the participation of students from secondary schools in the design and implement practical experiments in web environments to be used as a complementary learning tool;
- Promote the interest and the motivation for technical areas among higher education applicants.

The intervenient can be divided into three groups:

- Secondary students,
- Teachers from the secondary school;
- Teachers from the University.

This collaboration between these two institutions started in 2005 with some reports and publications [6, 7]. The protocol is well-defined in [6]. During last year, this initiative was extended to other university teachers from different departments. By doing this, we were trying to drive prospective students in different engineering fields. The teachers from the university came from different engineering fields: Mechanical, Electronics, Industrial Engineering and Informatics.

The secondary students came from the program study in the professional computing area.

In the next sections, it is described in detail the partnership established and still running between the university and the secondary school.

SECONDARY/HIGH SCHOOL PARTNERSHIP

The two educational level institutions are situated in Guimarães, in the region north of Portugal. Guimarães can be described as an industrial city predominantly with textiles industries. The University brings the technologies and knowledge required to the region development.

The students came from the professional informatics course. This is a three years course and on the final semester there is a period to be running outside the school, in a local business or in any other institution, as for example, another educational environment. In this period, the students can directly apply the concepts acquired during the course. At the end, students go working or continue studying in the university.

The Instituto Nun'Alvres, the institution where the students came from, formed a school called OFICINA (a Portuguese name), exclusively devoted to the technical

education. This is a defined strategic area for the Instituto as well for the region and the country. Even for Europe, the human resources development in new technologies is (or at least should be) a strategic area for the sustainable development of European economy and all the related parameters, as the European life quality.

OFICINA School endeavours on quality education and promotes strategic collaborations with local businesses and other educational institutions. Minho University is one of the partners. These collaborations, allow OFFICINA to know the needs and the worries of the future employers of their students. In this way they can properly drive students' education, preparing them for the real world needs and concerns, both in industry and university environments.

The projects proposed are within the scientific and pedagogical activities developed at the three Departments of the University of Minho and with the program curricula of the secondary school. The project runs in five months, in the Mechanical Department laboratory, located in the University of Minho, where students develop their practical work. The students come once a week to the university laboratory. An intermediate evaluation of the work developed is carried during the third week of project. This evaluation works as guidance to the students and stimulus to carry on the project. The final project evaluation will take place on the last week. It consists of a fifteen minute oral presentation given by the students followed by a five minutes period for questions and discussion. The student must also present a written report.

THE RUNNING PROJECTS

Several projects were proposed by the university team. Among them, the students chose three:

- Using Python to convert UPPAAL files (xml) into NuSMV files;
- Installing a PLC (Programmable Logic Controller) working net;
- Development of a webpage for a running R&D (Research and Development) project.

This year, there are four students attending the final period at the university. They were divided in one group of two elements and two groups of one element each.

I. Project 1 - Installing a PLC (Programmable Logic Controller) working net

This Project is performed by two students with the supervision of four university teachers from Mechanical, Industrial Electronics and Production System Departments.

The objective of the work is to implement a PLC industrial net that can be accessed by internet communication. This project is a particular task of a bigger project on virtual and remote laboratories. This PLC working net is to be used in Automation distance learning, as a remote control of small industrial prototypes.

II. Project 2 - Using Python to convert UPPAAL files (xml) into NuSMV files

This Project is performed by one student with the supervision of two university teachers from Mechanical and Informatics Departments. The objective of the work is to develop an application to convert the files generated by UPPAAL software (xml files type) in input files for NuSMV software.

This project is a continuation of previous works on the field that can be used as a starting point.

III. Project 3 - Development of a webpage for a running R&D (Research and Development) project

This Project is performed by one student with the supervision of the university team that participates in the overall project.

The objective of the project is to develop a web page and/or a platform repository of the information and documents related to the R&D project running at University of Minho.

SECONDARY/HIGHER SCHOOL PROJECT DEVELOPMENTS

The Bologna declaration brought significant adjustments in the high level education not only in Portugal as well as in several European countries. The learning process is centralized in the student. This implies not only a precise definition of objectives and capabilities to be acquired, but also strategies and teaching methodologies reformulation. The student should play the principal role in the learning/teaching process; he should be engaged in doing something besides listening to a lecturer and taking notes.

The authors believe that sooner the prospective university student deals with this new learning environment and methodology, the better.

Nevertheless, there are some difficulties that need to be overcome. At the beginning of the project, secondary students have natural problems of adaptation that easily and rapidly were overcome. The enthusiasm and motivation to work and study in a University environment were very important and positive.

Throughout observations, interviews and students' feedback, it was possible to understand that this new experience has some difficulties at the beginning but in general is a successful partnership.

At the midterm evaluation reports it could be seen that students were developing the proposed tasks in an organized mode. In this section some of the developed layouts are presented.

As for the Project 1, it is part of more general task. The authors, concerned with the new trends in educational system, bring together human and physical resources in order to reach these objectives, namely in the Automation and Control subjects. The team project proposes to develop, implement and set available in a Web environment a virtual and remote laboratory applied to the Automation and Control teaching/learning in Engineering (Figure 1). This laboratory will be for pedagogical use in undergraduate, graduate and pos graduate levels. The user chooses the practical problem to be solved, as well as remotely act and control the system

by running a default program or by developing the user own automation program. This last situation requires a well established PLC and computer network for remote access to the laboratory, Project 1 objective.



FIGURE 1
MPS – MODULAR PRODUCTION SYSTEM.

The students had some difficulties at the beginning, due to the lack of a detailed know-how on PLC programming. But, after a continuous guided assistance of the university teachers and as they came from Informatics area, it was quite straightforward to start running the project. The PLC network is now implemented and a webpage for remote access will be developed.

Project 2 is special important for developing an automatic tool for converting UPPAAL files (Figure 2) to NuSMV type files (Figure 3). This is particular relevant for formal verification of automatic digital controllers. This task is included in a R&D funded project.

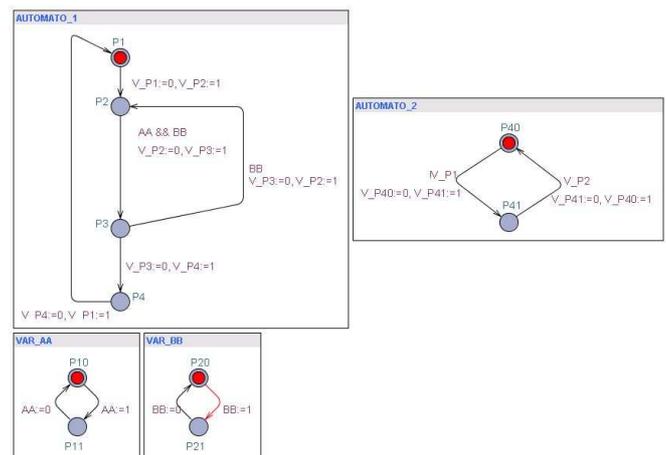


FIGURE 2
UPPAAL SOFTWARE

Project 3 has a straightforward application as to register and document the R&D running project. The idea is to develop a dynamic webpage where the information concerning not only to the project but also to the persons

involved, can be easily updated and available for consulting. The webpage is written in English and is still a working version (Figure 4).

```

MODULE main
IVAR
    FR : 1..7;
    AA : boolean;
    BB : boolean;

--*****
--*****
--*****
--AUTOMATO 1
VAR
    AUT1 : {P1, P2, P3, P4};
DEFINE
    V_P1 := AUT1=P1;
    V_P2 := AUT1=P2;
    V_P3 := AUT1=P3;
    V_P4 := AUT1=P4;
ASSIGN
    init(AUT1) := P1;
    next(AUT1) := case
        AUT1=P1 & FR=1 : P2;
        AUT1=P2 & FR=2 : P3;
        AUT1=P3 & BB & FR=3 : P2;
        AUT1=P3 & AA & BB & FR=4 : P4;
        AUT1=P4 & FR=5 : P1;
        1 : AUT1;
    esac;

--AUTOMATO 2
VAR
    AUT2 : {P40, P41};
DEFINE
    V_P40 := AUT2=P40;
    V_P41 := AUT2=P41;
ASSIGN
    init(AUT2) := P40;
    next(AUT2) := case
        AUT2=P40 & !V_P1 & FR=6 : P41;
        AUT2=P41 & V_P2 & FR=7 : P40;
        1 : AUT2;
    esac;

```

FIGURE 3
NUSMV SOFTWARE

All the projects needed a guided help from the university teachers, especially at the beginning. It was already expected as everything is new for these students: the environment, the teaching methodology, and the colleagues. Nevertheless, after the first impact, students react quite well and developing interesting tasks.

The students choose the INA' course as they have a close and strong relation with the technological area. Thus, the ultimate reason is not related to the possibility of having more opportunities in the future working environment. To confirm this idea 90% of the INA's students follow a university course.



FIGURE 4
PROJECT WEB PAGE.

CONCLUSIONS AND FUTURE WORK

A collaborative project between a higher institution education, University of Minho, and a secondary school, Instituto Nun'Alvres, was presented.

The evaluation of this program is supported on a qualitative analysis based on students' and teacher's (from university and secondary schools) feedback. After the initial period of getting acquainted with the expectations of this pilot project, secondary school students were enthusiastic and highly motivated with their projects developed at the University.

It should be pointed out that these programs are quite useful for secondary students as they are able to develop technical work always with a teachers' guided assistance. Especially, since the secondary school students will attend higher schools in one year time.

Another important characteristic of these projects is the possibility of promote new researchers in the fields of science and technology among the youth, sometimes difficult to achieve.

The partnership between secondary school and the university was successful resulting in a better understanding of their individual roles on the preparation of students' future. They are both able to detect candidate students' difficulties and limitations before entering higher educational programs.

It must be pointed out that, at this stage, the described projects are still running and the projects final presentations had not been yet carried out. Nevertheless, in general, the projects are interesting from secondary students' opinion and demonstrated to be benefit for both institution parts.

As a natural consequence of this success work, similar projects between the University institution and other secondary schools will be conducted in the near future. In these, a new rule will be tested. The idea is to promote the synergies between university and secondary students. They will work on a common objective exchanging tasks and ideas. They have different background and know-how, as well as the age and the interests are different. Even so, the authors are taking the risks in running this new experience.

ACKNOWLEDGMENT

The authors are grateful to Portuguese Foundation for Science and Technology (FCT) and the European Regional Development Fund (Feder) under Contract number POCTI/EME/61425/2004 and to R&D Centre Algoritmi for funding.

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