

ENHANCING UNIVERSITY-SCHOOL PARTNERSHIP: A PILOT STUDY

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Abstract. *This paper draws upon ongoing collaborative project between one higher institution education (University of Minho) and a secondary school (Instituto Nun'Alvres). The main goals of the project are to promote a more experimental teaching in connection with the national economic priorities, to develop the ability to technical and scientific research and innovation amongst the youth and to foster the interest and motivation for technical area among the higher education candidates. The project reported in this paper included six secondary students in total, three secondary school teachers and three engineering teachers from the University of Minho. Each of the students develops his own project, which includes wide diversity of tasks according to the different phases of project. In this paper, assessment procedures will be discussed namely, the evaluation taking place during the project and the final evaluation, which includes an oral presentation and a written report.*

Keywords: *University, Secondary School, Partnership*

1. Introduction

Since the society and the world in general continues to become more sophisticated technological and engineering applications, it is imperative that students should be prepared to enter into the workforce with the skills and levels of knowledge capable of sustaining such progress. As such, the need for students to become aware of such disciplines of engineering during their secondary school years is increasingly critical (Johnston, Wetherill and High, 2002). On the other hand, the constant changes in the industrial and social world, such as the migration of countless companies, are also very important challenge for the new generations, namely, the actual youth (Allan, 2005). Therefore, the University of Minho has celebrated a collaborative program with a secondary school (Instituto Nun'Alvres) in order to promote the science and technology among the young students. The ultimate goal of this partnership is to help instill an interest, and thus a desire, for students to potentially pursue higher education in science and engineering related fields. In addition to this collaboration between University of Minho and secondary school, a number of other indicatives have been taken in order to show the main scientific and pedagogical activities that are currently developed at the University of Minho, in special at the Mechanical Engineering Department. Visits to secondary schools, Summer University, open week university, special lessons and thematic sessions are examples of the activities promoted by the University of Minho.

The main purpose of this work is to present the project and to promote a more experimental teaching in connection with the national economic priorities, to develop the ability to technical and scientific research and innovation amongst the youth and to foster the interest and motivation for technical area among the higher education candidates. The project reported in this paper included six secondary students in total, three secondary school teachers and three engineering teachers from the University of Minho. Each of the students develops his own project, which includes wide diversity of tasks according to the different phases of project. In this paper, assessment procedures will be discussed namely, the evaluation taking place during the project and the final evaluation, which includes an oral presentation and a written report. This collaboration is expected to be helpful for educators and students to choose the higher school degree and, ultimately help students better for entrance into society. The remaining of the paper is organized as follows. In section two the general motivation for this work is presented. A short description of the protocol is given in section three. Two examples of students' projects are presented in section four. Finally, in last section the main conclusions from this work are drawn and the perspectives for future research are outlined.

2. Motivation for this work

The qualification of the Portuguese population has been identified as playing a crucial role in the social and economic development indispensable to continue the sustained development. This desideratum is essential for the improvement of the life conditions and safety of populations, which should reach the average of the other countries of the European Union. The European Union has been defined goals that intend to ensure that the European space becomes economically more competitive and intensify the capability of economic and social development. The *Innovation* and *Knowledge* were identified the sustentation pillars for this process and the motors for its implementation (Akay, 2003, De Graff and Christensen, 2004). To the University, as agent of creation of the knowledge and support and promotion the valorization of the knowledge chain, is attributed the mission to better concretize these objectives and to contribute to define the requisites that ensure the concretization of those objectives (see UNESCO report, 2000).

Indeed, the science, technology and innovation and the way how the universities and society, in general, use and disseminate the knowledge has assumed a crucial importance over the last few years. The system of science and Portuguese technology is in a convergent path with the average of European Union. However, the absolute values of the Portuguese reality are still reduced. For instance, for the year 2001, in Portugal the number of researchers per thousand of active population was equal to 3.4 against 5.3 of European Union (see CRUP report). Nevertheless, over the last years an evolution accentuated is verified thanks to scholarships programs promoted by the Portuguese Foundation for Science and Technology, which allowed the growth of the number of graduates and investigators in the scientific and technological fields.

The promotion and popularization of the scientific culture allow to the citizens a perception based in scientific bases of the world in that they live and of the society of the knowledge in that they are inserted. The promotion of the science for population, in general, and for the secondary school, in special, is of extreme importance, for being decisive for the capacities formation of scientific learning that they will be able to use along the life, and also for the importance of fomenting a critical spirit and of experimentation in the appropriation of the scientific culture.

This has been an important topic also analyzed and discussed in other countries such in the USA (Gidleya and Hampsona, 2004). Furthermore, the American Society of Mechanical Engineers (ASME) presented a work to promote a shared vision for the future mechanical engineering education in the context of new and rapidly emerging technologies and disciplines, national and global trends, societal and challenges for the 21st century, and associated opportunities for the profession. The ASME states that “Innovation in mechanical engineering education will prepare graduates to pursue their individual professional interests well beyond perceived boundaries associated with the discipline’s traditional roles, in keeping with the current and future applications and associated flexibility of the profession. In this way mechanical engineering will attract the best and the brightest students and faculty, including women and other traditionally underrepresented groups, many of whom may not otherwise consider entering the profession” (see ASME report, 2004). In addition, the ASME report emphasized that “a broad consensus has been developed about the need for a critical reexamination of engineering education in the context of the accelerating pace of change in society and the workplace. Among the factors that provide compelling reasons for this reexamination are: (i) the growing complexity and interdisciplinary foundations of engineering systems; (ii) the rapid emergence of new technologies; (iii) globalization as a principal driving force for change, accompanied by increasing global competition; (iv) prospective students’ interests that go well beyond perceived boundaries associated mechanical engineering’s traditional roles” (see ASME report, 2004).

The primary aims of this program celebrated between University of Minho and Instituto Nun’Alvres are: (i) to promote a more experimental teaching in connection with the national economic priorities, (ii) to develop the ability to technical and scientific research and innovation amongst the youth, (iii) to foster the interest and motivation for technical area among higher education candidates.

3. Protocol between University of Minho and Instituto Nun’Alvres

In this section the protocol celebrated between University of Minho and Instituto Nun’Alvres is presented in detail. The program includes a general meeting on the first week. During this meeting, the University of Minho informally presents their projects to be developed by each secondary school student. The projects are briefly introduced to all students so that they can choose the one they prefer. All the projects proposed are within the scientific and didactic activities developed at the Department of Mechanical Engineering of University of Minho. Furthermore, an important part of the projects deals with the computing science because the secondary school students are from the computing area and one the goal of this pilot project is to be an application of their knowledge to other fields such as mechanical engineering. In addition, during the first week of program, a general visit to Department of Mechanical Engineering is performed in order to show all students the laboratory facilities and the research work that exists at the department. Thus, the students can better understand what Mechanical Engineering is and it is related with computer and software science. This pilot program includes six secondary students. The selection of students is made by their secondary teachers according to their own criteria and taking into consideration the students’ interests. An efficient students selection process is critical for a successful experience.

The protocol celebrated between University of Minho and Instituto Nun'Alvres is based on the following premises:

- the teaching system should be understood as a set of resources through which the right to the education is concretized;
- this right should be developed with base of several structures and actions and under the responsibility of different institutions;
- more and more it is necessary to promote the engineering courses near the secondary students;
- one of missions and vocations of the University of Minho is to render services at the involving community, in general, an at the secondary schools, in particular;
- the secondary schools need for technological and library resources capable to turn their teaching system more attractive to the students.

The terms that govern the protocol University of Minho-Instituto Nun'Alvres are listed below;

1. *Purposes*

- o the present protocol has as objective the cooperation between the two granting in order to congregate the efforts tending to create dynamism at the teaching system and to touch the students of Instituto Nun'Alvres for the graduate courses of the University of Minho;
- o the University of Minho indents to give technical, scientific and didactic support to Instituto Nun'Alvres;
- o the University of Minho allow access to the library of the teachers of the Instituto Nun'Alvres;

2. *Application form*

- o the intervention of both part should be properly formalized by one of the parts and authorized by the other one;
- o within the constraints resulting from the annual schedule of the teaching activities of the University of Minho, it is given maximum cooperation to Instituto Nun'Alvres in order to offer their students thematic lessons and visits to the University of Minho laboratories;
- o Lectures and other interventions of the University of Minho members should always be integrated in the Instituto Nun'Alvres activities;

3. *Attendance/Accompaniment*

- o the accompaniment of the present protocol and annual schedule is done by a mixed committee defined by University of Minho and Instituto Nun'Alvres;
- o the duration of the committee members is one year and is successively and automatically renewed while there is no deliberation in opposite for one of the parts;

4. *Protocol duration and formalization*

- o the present protocol is valid for two years and is automatically renewed if it is not denounced by any of the parts;
- o the actions resulting from the present protocol are properly formalized through addenda that should consist of action description, objectives, periods and dates of realization, team constitution and the indication of the organic units involved, identification of the responsible members by the coordination and others relevant specifications.

It was also celebrated an addendum to the protocol between the University of Minho and the Instituto Nun'Alvres in the sense of the conjugation of efforts to reach the following statements:

- to contribute for a teaching more experimental and connected with the reality of the national economy;
- to contribute to develop innovation capacities and technical and scientific investigation in the layers more youths of the population;
- to promote and motivate, in a close future, the students of the technological areas for the entrance in the academic degrees of the University of Minho.

The terms that govern the addendum to the protocol are listed below;

1. *Partners*

- o the School of Engineering, through its Department of Mechanical Engineering intends to receive between January and May of 2005, six students of Instituto Nun'Alvres of the Computation professional course, of the twelve year of secondary school, to perform their professional apprenticeship;

2. *Main objectives, conditions and parameters that characterize the apprenticeships*

- o to develop the creativity and the permeability of the trainee to the technical and scientific innovation;
- o to complete the trainee's technician-scientific formation relating the previous knowledge of the same with current investigation works in Department of Mechanical Engineering;

3. *Specific objectives*

- o to define for the responsible teachers of Department of Mechanical Engineering for the proposition of each apprenticeship;

4. *Duration*

- o the duration of the apprenticeships is of five months, beginning on January of 2005;

5. Attendance/Accompaniment

- the Instituto Nun'Alvres, designate one or more responsible teachers for the trainee's attendance. They visit the Department of Mechanical Engineering at least twice during the apprenticeship;
- at the Department of Mechanical Engineering, the teacher(s) that propose an apprenticeship are responsible for the academic-scientific trainee's;
- The student trainee, weekly, gives to know to the responsible teachers (of Department of Mechanical Engineering and of Instituto Nun'Alvres) the performed work in that week and will adjust the evolution of his work according to teachers' feedback;
- Department of Mechanical Engineering assumes the responsibility to create all of the necessary work conditions for the successes of the apprenticeship works proposed;
- the student's trainees are considered as external readers of the Libraries of the University of Minho, without any taxes;

6. Classification

- the evaluation along the apprenticeship is based on qualitative parameters existing in a grill, previously elaborated for the teachers of Instituto Nun'Alvres that it is of the student's knowledge;
- at the end of the apprenticeship, after public presentation and after appreciation of a report corresponding to the performed work, all the responsible teachers (of Department of Mechanical Engineering and of Instituto Nun'Alvres), of each work, they will attribute a quantitative classification (rang from 0 to 20 values). The final note will be the average of the classifications attributed by teachers of Department of Mechanical Engineering and of Instituto Nun'Alvres, with equal weight;

7. Others

- the traineeship takes place in the facilities of Department of Mechanical Engineering, which are at the Campus of Azurém, in Guimarães;
- the apprenticeship doesn't have vinculum character; Department of Mechanical Engineering doesn't assume to integrate the student trainee in their own services, when finish the apprenticeship;
- the apprenticeship is not subject to any remuneration type;
- in the dislocations Instituto Nun'Alvres/Department of Mechanical Engineering or vice-versa, the trainee is covered for the school insurance of Instituto Nun'Alvres.

4. Examples of students' projects

This section presents two examples of the projects developed by the students. The projects proposed are within the scientific and pedagogical activities developed at the Department of Mechanical Engineering and with the spirit of the subject program of secondary school. It should be highlighted that all the students involved in this collaborative program study in the computing area. The duration of the projects is five months, during this period the students visit the Department of Mechanical Engineering in order to contact their advisers and develop their work. In addition, they visit the University facilities such as the library, laboratories, etc. An intermediate evaluation of the work developed is carried during the third week of the project. This evaluation process is primarily formative in nature with the main goal of keeping students motivated and informed about the effectiveness of the project. A formal end of each project is always held on the last week of the program. During this final session, a ten to fifteen minute presentation is given by each student highlighting his research work followed by a five minute period for questions and discussion.

4.1. Example 1

Title: Development of a computational program for automatic drawing of cam-follower mechanisms.

Description: Cams are mechanical elements which surfaces can present several forms. These mechanisms are applied in machines and mechanical systems in industry, such as in textile machinery, tool machines, computing equipment, among others. Figure 1 shows schematically a cam-follower mechanism, in which the cam is radial and the follower is translational concentric of roller type. In the same figure is some basic nomenclature, namely, cam profile, tracing point, primitive curve, base circle and primitive circle.

Objective: The main goal of this project is to develop a computational program that allows drawing automatically the profile of cam mechanisms.

Basic knowledge: Since the work is to be developed with software *Visual Basic*, the student should be able to design computational algorithms and expertise in computation.

Work plane: This project includes seven main tasks that are summarized in what follows:

1. Bibliographical revision on the field of computing, namely on the software used;

2. Description and characterization of the cam-follower mechanism selected for this study;
3. Design adequate algorithms to carry out this project;
4. Implementation the algorithms developed in the *Visual Basic* language;
5. Test and validation of the computational program developed;
6. Written a technical report (up to 30 pages) which contains the work performed by the student;
7. Oral presentation of the work produced.

Supervision: The student develops his own work under the supervision of two teachers, one from the University of Minho and another one from Instituto Nun'Alvres.

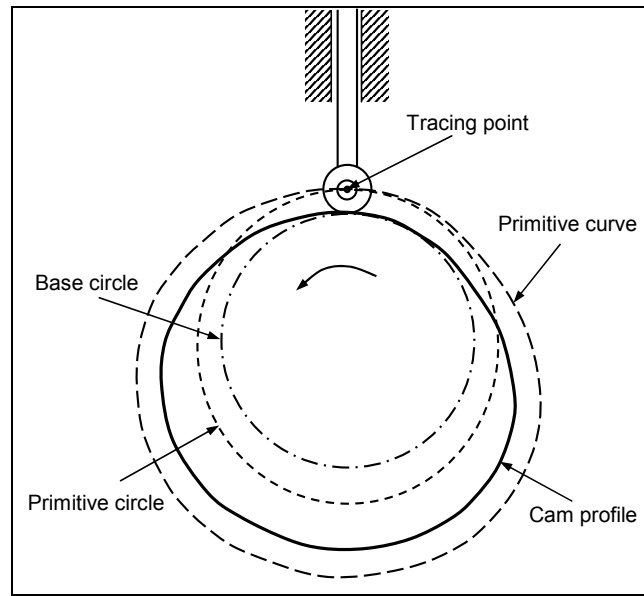


Figure 1. Schematic representation of a cam-follower mechanism

The chronogram and schedule containing the tasks of this project can be summarized in the Tab. 1.

Table 1. Chronogram containing the tasks of the student's project 1.

Tasks	1 st month				2 nd month				3 rd month				4 th month				5 th month			
	week				week				week				week				Week			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1																				
2																				
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4.2. Example 2

Title: Development of a computational program for determination of the main parameter of the quality of a file.

Description: The practice shows that the most efficient way of generating the file cutting edges is by penetration, due to impact of a cutting tool, which creates a plastic deformation on the file body. The penetration depth is probably the most important factor of the final quality of a file. The figure 2 shows the design close-loop control for the penetration depth of the chisel implemented in an industrial file machine. For that, first of all, it was necessary a high rate acquisition for the chisel displacement signal (*LVDT – Linear Variable Differential Transformer*) and the electric contact (chisel-file) signal, followed with a data analysis to compute the penetration depth. According to the error obtained, a correction output its produced (step motor actuation).

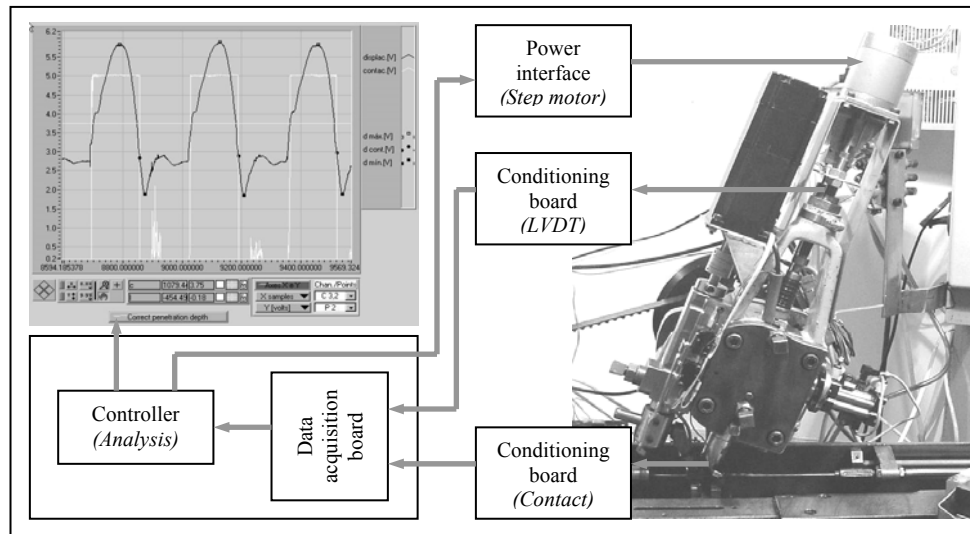


Figure 2. Schematic representation of the close-loop control for the file teeth production.

Objective: The main goal of this project is to develop a computational program to perform automatically the calculation of the penetration depth of the chisel that allows the close-loop control of the file cutting operation.

Basic knowledge: Since the work is to be developed with software *Visual Basic*, the student should be able to design computational algorithms and expertise in computation.

Work plane: This project includes seven main tasks that are summarized in what follows:

1. Bibliographical revision on the field of computing, namely on the software *Visual Basic*;
2. Description and characterization of the close-loop control of the file teeth production implemented in the industrial file machine;
3. Design adequate algorithms to perform the data treatment required;
4. Implementation the algorithms developed in the *Visual Basic* language;
5. Check and validation of the computational program developed;
6. Written a technical report (up to 30 pages) which contains the work performed by the student;
7. Oral presentation of the work produced.

Supervision: The student develops his own work under the supervision of two teachers, one from the University of Minho and another one from Instituto Nun'Alvres.

The chronogram and schedule containing the tasks of this project can be summarized in the Tab. 2.

Table 2. Chronogram containing the tasks of the student's project 2.

Tasks	1 st month				2 nd month				3 rd month				4 th month				5 th month			
	week				week				week				week				Week			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
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5. Conluding remarks

A collaborative project between one higher institution education (University of Minho) and a secondary school (Instituto Nun'Alvres) was presented and discussed throughout this paper.

The evaluation of this program is based on qualitative and quantitative methods data collected from students' feedback. Through observations, interviews and students' feedback and anecdotal evidence, it is clear that, after the initial period of getting acquainted with the expectations of this pilot project, secondary school students are enthusiastic and highly motivated with their projects developed at the University of Minho. It should be highlighted that these kind of programs are quite useful for secondary students in the measure of they can developed some work by themselves with the orientation of the supervisors. This aspect gains paramount importance since the secondary school students will enter into the higher school in one year. Another important characteristic of these projects is the possibility of promote new researchers in the fields of science and technology among the youth, namely in the context of the Portuguese economy and industry, where the development of new products with high value play a crucial role for success.

Additional beneficial results that have been observed include an improved relations and communication between university and secondary school, namely in what concerns to their interests and expectations. As the program continues to mature and expanded, the potential benefits to be reaped are numerous and have multiple foci. Communication and partnership between secondary school and the university was enhancing, resulting in a better understanding of what each can contributes to preparation of students for their future. University is able to help guide and students preparation to leave secondary school and enter the post-secondary arena. Additionally, university gains an understanding of the limitations and issues facing students prior to them entering their programs.

Overall, the broad project was 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 of Minho and other secondary schools will be conducted in the near future.

6. References

- Akay A., 2003, "The Renaissance Engineer: Educating Engineers in a Post-9/11 World", *European Journal of Engineering Education*, Vol. 28(2), pp. 145-150.
- Allan S.B., 2005, "The China Road – The outsourcing option isn't as cheap or as easy as it looks", *Mechanical Engineering*, Vol. 127(3), pp. 36-40.
- ASME – American Society of Mechanical Engineers, "A Vision of the Future of Mechanical Engineering Education", ASME International, September 2004.
- CRUP (*Conselho de Reitores da Univesidades Portuguesas*), "A Universidade Pública Portuguesa: Reflexão para uma política de desenvolvimento", Available on www.crup.pt on May 10th 2005.
- De Graaff, E. and Christensen, H.P., 2004, "Editorial: Theme issue on the active learning in engineering education", *European Journal of Engineering Education*, Vol. 29(4), pp. 461-463.
- Gidleya J. and Hampsona G., 2004, "The evolution of futures in school education", Elsevier, USA.
- Johnston, B., Wetherill, K. and High, H., 2002, "Teacher socialization: oportunities for university-school partnership to improve professional cultures", *The High School Journal*, Vol. 85(4), pp. 23-39.
- UNESCO, 2000, "World Education Report: the Right to Education". UNESCO, Paris.