TEACHING & RESEARCHING: TEACHING YOUNG STUDENTS HOW TO MAKE RESAERCH @FEUP

Maria Teresa Restivo[1]

Abstract *— In the presentation it will be consider some of the author teaching/learning/research activity outcomes at the Faculty of Engineering of the University of Porto (FEUP), Portugal, since the she became its member in eighties and, particularly, along the present decade, within courses or extra-curricular student/teacher/researcher in either formal or informal multidisciplinary project based learning methodologies. The results from these experiences have been a unique opportunity for the author and gave to the students' also important contribution for their deeper knowledge by practicing the problem analysis, decision and resolution and training, including team work and leadership skills. This activity is also related with the author interests at the Unit of System Integration and Process Automation (UISPA) from the Institute of Mechanical Engineering (IDMEC-Polo FEUP). In this context the author joined intensively the two complementary tasks: teaching and R&D.*

Index Terms — Project based learning, teaching and researching,engaging students in R&D.

SHORT INTRODUCTION

The presentation will consider some of the author teaching/learning/research activity outcomes at the Faculty of Engineering of the University of Porto (FEUP), Portugal, since she became assistant lecturer in 1979 and, particularly, along the present decade, within courses or extra-curricular student/teacher/researcher involvements, using either formal or informal multidisciplinary project based learning methodologies. The author entered the research carrier by the end of 1984 but, since then, she has been constantly involved with teaching, both at undergraduate and postgraduate level. The results from different teaching/learning/research experiences have been a unique opportunity for the author and gave to the students also important contribution for their deeper knowledge by practicing the problem analysis, decision and resolution and training, including team work, leadership skills, public presentation practice and even at competition level. In these experiences, many of them supported by the project based learning approach, the teachers/researchers played the role of tutors, facilitators and co-learners, as well. The author played this role as course leader, project team leader or project team element. This activity has influenced, in some interest way, Unit of her at the System Integration and Process Automation (UISPA) from the Institute of Mechanical Engineering (IDMEC-Polo FEUP), and from the Portuguese Associated Laboratory for Energy, Transports and Aeronautics (LAETA). IDMEC is an Institute created under a Science Development Program of the Portuguese Science Foundation, in 1991, and LAETA was homologated by the Portuguese Ministry of Science and Technology in 2006 and was officially created at June 2008, as a Centre of Excellence. The author is currently the coordinator of UISPA since 2007 and is a scientific council board element from LAETA. In the context described above the author joined the two complementary tasks always involving teaching goals, as well. From these involvements comes the talk title: ***Teaching & Researching: teaching young students how to make research at FEUP***.

THE VALUE OF THE MULTIDISCIPLINARY ACTIVITY

The inherent multidisciplinary activity has also been a fundamental condition for many of the results. The fact that the author got a physics degree in the experimental scientific area of solid state physics pushed her into metrology - the science of measurement. Measurement is the basis of science. Instrumentation for measurement is vital for the design and the implementation of measuring, monitoring and actuation systems and in data acquisition and processing. All these issues are basic tools in many areas as, for example, in sciences, in any technological area, in health and sports, in biology, and also in certification as well as in control and information engineering, figure 1.

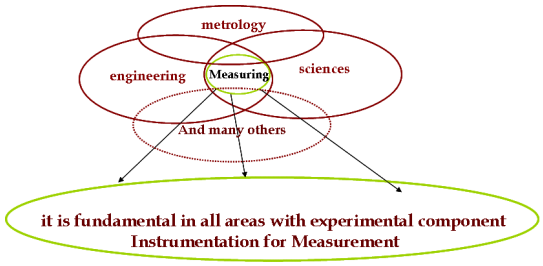

FIGURE. 1
PHYSICS AND METROLOGY - MULTIDISCIPLINARY SCOPE

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THE WALKED WAY

In the eighties the author teaching involved, as much as possible, collaboration with other colleagues from different courses which facilitated the use and the access to more sophisticated equipments or to specimen production. This was the beginning of her self-learned methodology in project based learning.

Later, in the nineties she became the leader of a research activity group in the Mechanical Engineering Research Centre and in 1994 the coordinator of the sensors and transducers area at the Physics, Acoustics and Telecommunication Research Unit up to 2000. During the nineties she has been involved in post-graduate advanced courses and she has also collaborated in the development of a new curriculum for the mechanical engineering degree. By the end of the nineties she had the opportunity to attend lifelong learning courses at FEUP oriented to the engineering teaching field. Then she became more thorough in the PBL methodology practice "by learning it in a supervised way".

Since 2000 the author has been responsible for the newly created Laboratory of Instrumentation for Measurement (LIM), in the Mechanical Engineering Department at FEUP. It has a dedicated area around 80m2, offering fundamental equipment for Lab sessions as well as extra-curricular and R&D initiatives. LIM has, since then, involved itself within the broad area of Instrumentation for Engineering Measurement and has been the nest to an intensive cross-fertilization between students, teachers/researchers, within FEUP [1], the University of Porto (UP) and other Portuguese and foreign Universities [2 - 11]. In this atmosphere all the participants have been strongly encouraged in the experimental field using simple real world open problems for self-motivation and for exploring the relativity of real problem solutions – this means the way how many real problems should be faced -. Very often the groups of students were from different engineering areas and levels. And, sometimes, they also involved students and teachers/ researchers from non-engineering areas, like nutrition, sciences, humanities, arts and, in a few cases, from other Universities in Portugal or even foreign elements. In the present decade these projects have often been of long-term extra-curricular type, student-centered, interdisciplinary and using real everyday problems or practices [12].

The dissemination of experimental activities has also been a strong "must" by making available free remote lab access, for everyone, 24-hours a day and seven days a week. Additionally to other dissemination activities, an educational prototype website for youngsters up to high school level has been prepared as well as the organization and the collaboration with UJr – Junior University since 2004, [13]. The UJr at University of Porto is a unique experience in the world which is opening all UP's Faculties and Institutes to all youngest. Every year, in July, the UP Academy is open to students from all over the country for many different activities and around 5000 students come and co-exist with the normal academic life.

The communication will show with detail some of the referred author experience, related with the projects listed in the Table 1.

TABLE I
EXAMPLES OF PBL APPROACHES ALONG THE PRESENT DECADE

Year	Project Name	Main Objective
2001	The beverage can (leader)	A beverage can gave rise to many studies related with its structure behavior during the can opening process
2003	EMPE – Exploration of Multidisciplinary Engineering Problems (Co-leader)	This project was the nest of a strong involvement of colleagues and students from many engineering departments@FEUP
2004	Residual stress measurement in composite materials using optical fiber sensors (team element)	Hole method evaluation applied to composite materials and comparison of fiber optical sensors behavior with traditional rosette strain gauges
2004	Displacement transducer for civil engineering applications (leader)	Development of a low cost displacement transducer to be used in historic building rehabilitation
2005	Remote measurement of μdisplacement (leader)	Development of an automated system for on-line access a Michelson Interferometer
2005	Displacement transducer for monitoring civil engineering applications, (team element)	To test Hall sensor displacement transducer characteristics and to compare its monitoring performance with a commercial one.
2005	Body composition evaluation using skinfold calliper and bio impedance analyses, (team element)	The use of the two portable methods for body composition evaluation would require improvements on their performance and low price production
2005	UJr – Young University	During July, around 5.000 students, from 10 to 17 years old, stay within the Faculties of University of Porto, involved in many different activities
2006	Experimenta@feup (co-leader)	To improve the remote and virtual labs at FEUP as well as to continue the educational prototype web site
2007	Experimental and virtual tools for teaching structural mechanics (team element)	To develop an experimental structure for evaluating dynamic behavior and to develop, using free software, a virtual structural mechanics work bench
2007	Development of an Hand Grip Dynanometer for Nutritional Assessment (team element)	To develop a sensor device for Handgrip Strength of a wide range, of low cost with low/no maintenance which implies a robust design of the sensing system as well as the complementary electronics involved

2007	Virtual instrumentation for monitoring, digital recording and assessing body composition (leader)	To sensorize a skinfold caliper, to develop a software application integrating a database and to incorporate a wireless communication between the pc and the calliper for evaluating the body composition
2009	SeepTool – Small scale equipment for phenomena associated with ground water flow (team element)	An experimental prototype was designed, produced, assembled and tuned in order to permit the visualization of phenomena associated with ground water flow
2009	Optical fiber sensors for studying of ground water flow (team element)	Development of an optical fiber sensor for measuring pressures for studying ground water flow.
2009	LipoTool – mechanical design of a new skinfolder calliper (leader)	A new mechanical design has to be developed in order to upgrade a skinfold calliper performance. A new digital sensorization and wireless communication is also under development

FINAL COMMENTS

All the above experiences have been of big interest to the author. She has been learning the main advantages of working in an active and creative team in the context of teaching/learning engineering problems.

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