Special Session: Performance-Centered Adaptive Curriculum for Employment Needs

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***Abstract*— The global competitive labor market and industrial sectorial trends have demanded new requirements and restructuring in the prevailing engineering curriculum of the European Higher Education Area (EHEA) in terms of linking the educational contents with the industrial real-world, and, on the other hand, promoting cooperation between universities and enterprises. In response to these needs, the Performance-Centered Adaptive Curriculum for Employment Needs (PAC) project was launched in order to develop business adaptive and employment and labor market oriented master degree programs for computer, electronics, and fiber-optics engineering. The project aims to input business and employment into curriculum development. Likewise, it considers concrete and specific new standards of industry at national and regional level, not only in terms of formal qualifications but also in terms of detailed new skills requirements and competences. Thus, it will be able to foster employment by preparing qualified professional profiles in a particular occupation. The project provides virtual mobility of students and teachers by developing open educational resources on-line within the framework DIPSEIL (Distributed Internet-Based Performance Support Environment for Individualized Learning) which is released in five languages to organize different courses from available modules and tasks for performance according to the needs of a specific job place. These educational resources comprise innovative ICT-based learning content, services, pedagogies and practice for lifelong learning and vocational training. The PAC project is based on a partnership between European universities and enterprises and it supports progress towards European-wide certification of qualifications. In this session, the project is presented outlining the main objectives and the contributions carried out by each partner.**

Keywords-component; Performance-Centered; Training, Adaptive Curriculum; Employment Needs; Engineering Education

I. INTRODUCTION

Following the EU's renewed Lisbon Strategy for Growth and Jobs and the recently launched new Skills for New Jobs initiative, as well as the Comprehensive Sectorial Analysis of Emerging Competences and Economic Activities in the European Union[1], this project is aiming to develop and ensure a competence-based, performance-centered, adaptive curriculum at master degree level, which will support individuals in developing the right skill mix relevant to current and future labor market needs.

The scope of the project is based upon Cedefop's latest forecast on the demand and supply of skills, which foresees a steady rise in knowledge- and skill-intensive occupations. The research estimates that the total number of job openings will reach around 80 million by 2020, with the biggest increase in high-level managerial, professional and technical occupations. These higher level jobs are expected to increase to around 8.5 million over the next decade, and to gain a share of more than 42% of total employment. The experts with higher qualifications will therefore clearly be in the best position to take advantage of these developments.

[1] Skills in Computer, Electronic and Optical Products Sector, Report on Scenarios, implications and options in anticipation of future skills and knowledge needs, TNO Netherlands Organization for applied Scientific Research SEOR Erasmus University Rotterdam, ZSI Centre for Social Innovation, May 2009, DG EMPL project VC/2007/0866, Lot 7, Computer, Electronic and Optical Products.

II. PROJECT DEVELOPMENT AND EXPECTED RESULTS

Recent studies also predict that the gradual shift in Europe away from the primary sector and traditional manufacturing industries towards services and a knowledge-intensive economy is likely to continue. By the year 2020, almost three quarters of the jobs in the EU-25 are expected to be in services. Business and miscellaneous service specialists respectively will have the best prospects, with around seven million additional job openings being created between 2010 and 2020. Essentially the same trends are evident in the Plovdiv Region. The structure of the regional economy is shifting towards knowledge-intensive service industry – telecommunications and IT services.

Our substantial educational expertise also indicates that in Bulgaria, learning based solely on lecture-practice-test training systems does not respond adequately to future challenges for individuals, society and the economy. A high percentage of our students with a higher-level of specific skills are not able to fit in the current work context and usually occupy lower-level jobs.

The significance of these findings have prompted us to launch the PAC project aiming to provide a specific job position oriented curriculum at master degree level that will upgrade the basic skills and knowledge and ensure transversal (?) competences of bachelor degree graduates so that they can respond and adapt more adequately to changing society and new requirements of the labor market.

To ensure the sustainability and the successful realization of the PAC project, Plovdiv University "Paisii Hilendarski", will cooperate with the Spanish University for Distance Education (UNED) and the consultancy company International Software Consulting Network GesmbH (ISCN) which has extensive experience in the automotive and software industry labor market. So far, the partners have had two successfully implemented projects - DIPSEIL[2] and IPLECS - that will serve as a base for the development of the present one.

Plovdiv University has almost five years of experience in the implementation of performance support system principles in traditional university education and PSS Learning Objects in DIPSEIL CMLS as well as in Physics Engineering, Medical Physics, Information Physics and Communications bachelor degree courses and also in Information and Communications Systems master degree courses. The UNED, for its part, has considerable experience in university-industry cooperation and will facilitate the link of the program with the labor market. The co-operation with ISCN which has founded the European Certificates Association will ensure the sustainability of the project and will pave the way for setting up a European system for accreditation of the newly identified job positions.

Partnerships between universities on the one hand and enterprises on the other, are crucial when it comes to matching the needs for skills in the labor market with those which students can actually offer. In this regard our industry partners Index 6, TepolSofts, Adex, Global Communication Net AD, KCM Plovdiv and ZF Friedrichshafen AG, which operate in the field of the adaptive performance-centered curriculum will help us in skills and personal competence profile identification.

At the first stage of the project the potential of employers' surveys will be explored as a tool for analyzing the skills and abilities needed for fiber-optic, technology and control systems and electronic and software engineering job positions. With the active participation of all partnering organizations, at the next stage, the right skills portfolio will be defined and a matrix of learning outcomes will be developed. Overlapping areas in competence profiles and higher education programs will be identified with the support of experts and representatives from different departments and laboratories of higher education institutions. Going forward the project team will take into account the outlined key competences and will develop ~~a~~ tailor-made training curriculum, teaching, delivery and assessment methods, adapted to the relevant job positions.

Aims, tasks and methodology of the main work-packages.

WP2 aim: to develop, in consolation with the European partners, a skills set for the job roles in IT, control systems, electronic and software engineering, according to the needs of labour market and taking into account VET and qualifications systems changes such as the shift to learning outcomes and competence-based systems. WP2 objective: Identification of new demands for qualifications – identification of current skills needs and new requirements for competences in control systems, electronic, automation and software engineering. WP2 tasks: 1. Starting first four months with the jobs and needs analysis; 2. Structuring the skills according to skill set standards outlined in the EQN guide

(chapter 2 part 2 European Qualification Network, http://www.iscn.com/projects/eucertificates/program/eqn2007-guideline.zip). Providing support in the generation of skill profiles for users. WP2 methodology used: For 1. Job analysis: Instructional designers from PU and UNED-DIEEC will interview the researchers and professionals from the industrial partners; will study the documents at the enterprises. With the involvement of PU, UNED-DIEEC and ISCN experts the necessary skills and underlying knowledge will be defined, the competences for job performing will be determined and the matrix of learning outcomes will be developed. Then an analysis will be done to identify the overlapping areas of the identified qualifications and the competence profiles of existing higher education programmes. WP2 need analysis: Training need analysis will be performed with questionnaires and interviews with managers and professionals from the enterprises in the sector, social workers of the regional employment services, graduated students; analysis of the statistics of the labour market and of the trends in VET as well as the university formal education in the same sector in Europe (through literature study) will be done.

WP3 aim: to develop a complete performance-centred curriculum in the field of technology and engineering adapting specialization part of the curriculum to the needs of skills, knowledge and competences identified in WP2. WP3

[2] Distributed Internet-based Performance Support Environment for Individualized Learning DIPSEIL 225692-CP-1-2005-1-BG-MINERVA-M Internet-based Performance-centered Learning Environment for Curricula Support IPLECS 141944-LLP-2008-1-ES-ERASMUS-ECDSP

objective: Development of qualification profiles – knowledge, skills and competences in learning outcomes, curriculum framework. WP3 tasks: Design three scenarios: Pick a learning related domain in a specific context and define a relevant problem; Develop an educational scenario and activities around this problem; Illustrate and define all the components of this scenario. Example: For a company from the identified industry area, a specialist in IT is necessary. This specialist has to know, to be able to do and to be competent in: Object oriented programming (Delphi , C#). SQL - Firebird or MS SQL. Basic knowledge in the field of Creation and Maintenance of computer networks. Basic knowledge in the field of maintenance and administration of computer systems and Windows operating systems (Windows XP, Windows Vista, Windows 7). The suggested method for designing educational activities in this proposal is scenario-based design-technique that seeks to exploit the complexity and fluidity of design by trying to learn more about the structure and dynamics of the problem under exploration. This is accomplished while trying to see the design situation in many different ways, and interacting intimately with concrete elements of it. Scenarios should have the following characteristics: setting, actors, goals or objectives and actions and events. Main activities in ICS curriculum development: Consult the Universities mission statements, General education learning outcomes, Department initiatives, Budgetary support, for assistance in preparatory activities; Process flowchart, overview, submission deadlines and schedule; Courses specification – consideration, recommendation and approval from the team and review team from different universities; Prepare documents – Program development form, Course outline form, syllabus form, action verb list for learning outcomes for each course; Admission and qualification requirements. WP3 main activities: Instructional design; Learning materials prototyping; Filling pool of learning materials; Evaluation of the first prototypes of the learning resources. Each author will create the learning materials in his or her own language. All courses will be available in English too. We intent to develop the learning resources for the courses from the PAC program, we will use also existing learning resources on DIPSEIL data-base (tasks for performance) to complete and organize modules and complete courses from the PAC curriculum - these courses will be presented according to the PAC workflow model (pool of learning resources

Methodology for developing performance-centered learning resources. Acquiring knowledge in the contexts in which it is to be used facilitates recall and knowledge application. In the eLearning courses adaptation/development the advantages of the electronic performance support systems will be transferred, e.g. the subject matter expert creates the knowledge model with concepts, support material, reference information; then the instructional designer defines the objectives; then the transactions, i.e. what tasks should be performed to reach the objective, their optimisation, grouping, connection with the concepts, and the expert advices how to perform tasks are generated. The knowledge base will collect the trainees' experiences and help to enrich the expert system.

WP4 aim: Implementation of developed in WP3 curriculum in partners' educational contexts. WP4 objective: Testing Performance-centred Adaptive Curriculum for qualification. WP4 tasks: Test of the developed curriculum will be performed with at least 10 students at UNED and PU. The program will start the first semester with the core courses – the same for the identified qualifications. For example: courses like Advanced Information Systems, Software Systems Engineering, Advanced Electronics. Courses will be available in Bulgarian, Spanish and English (courses available in DIPSEIL are available in five languages, new developed courses will be developed in these three languages). During the second semester students will study specialized courses according to the chosen qualification. For example: for software engineering qualification - courses in programming languages, for automation and control qualification – courses in CAD systems, VHDL.

Courses in forms of modules with tasks for performance are/will be available in DIPSEIL. Students will work from the distance and in the labs of PU and UNED-DIEEC for tasks where the practical performance is necessary. During the specialisation phase, students will work closely with the professionals from the supporting enterprises using their environment, tools and equipment, and their experts support in form of feedback and evaluation of tasks performance.

PAC curriculum implementation in the partners context, in a study year is:

- One year (courses) > 60 ECTS
  - Two semesters
    - 4 compulsory subjects (first semester)
    - 2 compulsory subjects (second semester)
    - 4 elective subjects (second semester)
- Half year (final Thesis)
  - NOT inside the project

Courses

- 7,5 ECTS (187,5 student hours)
- Includes collaborative and evaluation

- Group
  - 5-10 students

2-4 elective subjects

The basic characteristic of the PAC training curriculum will be its adaptability. It will be built upon a technical platform that consists of a pool of learning resources available in five languages in the DIPSEIL courses data-base. The curricula will be performance, task-based, mobile-oriented, and based on collaborative work inside the DIPSEIL environment.

PAC training of the students will be further strengthened through relevant engineering work experience. Two months internship programs will be opened for the participants so that they can integrate learning with working life and further develop the corresponding vocational skills. Knowledge, skills and competence assessment will be performed by each of the employees. As key contributors to the initiative, they will present evaluation reports which will capture the range of outcomes desired and will give an overview, of the results and lessons learned.

The implementation of the program will represent a significant step forward in the transformation of the learning and educational process from a traditional lecture-practice-test training approach to an innovative performance-centered one.

The impact of the project will foster motivation and value in learning and will enhance the relationship between skills providers and employers. At a regional level it will support Bulgaria in its efforts to align its higher educational framework with modern European best practice and standards.

Here we include a brief synopsis of the papers to be included in this Special Session.

A. Plovdiv University expertise and solutions in performance-centered adaptive curriculum for the needs of industry in Plovdiv region

Plovdiv University has almost five years' experience in the implementation of performance support system principles in traditional university education and PSS Learning Objects in DIPSEIL CMLS as well as in Physics Engineering, Medical Physics and Information Physics and Communications bachelor degree courses and in Information and Communications Systems master degree courses. Partnerships between universities on the one hand and enterprises on the other are crucial when it comes to matching the needs for skills on the labor market in the region with those students can actually offer. In this regard our industry partners Index 6 and TepolSofts, which operate in the field of the adaptive performance-centered curriculum, will help us in skills and personal competence profiles identification.

At the first stage of the project the potential of employers' surveys will be explored as a tool for analyzing the skills and abilities needed for electronic and software engineering job positions. The right skills portfolio will be defined and a matrix of learning outcomes will be developed. The overlapping areas in the competence profiles and the higher education programs at Plovdiv University will be identified. Going forward the three organizations will take into account the outlined key competences and will develop a tailor-made training PAC curriculum, teaching, delivery and assessment methods adapted to the relevant job positions. The basic characteristic of the PAC training curriculum will be its adaptability.

This will be a joint paper from Plovdiv University, INDEX-6and TEPOLSoftS.

B. European strategy for joint education and certification involving both industry and universities

ECQA (European Certification and Qualification Association) is an certification body which was established with the support of the Life Long Learning program and currently represents 68 training bodies in 28 countries, 27 certified professions, and Europe wide agreed exam processes and exam portals. Currently in ECQA a new concept for ECTS points for training modules has been developed, where the same training modules of a profession (e.g. integrated design engineer) are accepted on both sides, with ECTS points in universities and as an industry certificate recognized by leading European industry.

This is a paper from the ISCN (International Software Consulting Network).

C. Curricular development required to support Adaptive Predictive Expert control projects and business in industry

This paper has been written to identify the needs and competencies required for new graduate student intake in a small company dedicated to the design and build of process control systems for a variety of applications in a diverse range of industries.

While emphasis is placed on core technical competencies such as IT, electronics, control techniques, basic process knowledge, project management and perhaps an ability to relate to diverse and possibly unfamiliar industries from a control perspective, there is also an emphasis on the softer cognitive skills such as communication, presentation and being effective in a team. There should be a recognition among students that base skills will change as the industrial environment changes and new technologies emerge.

The combination of skills required should lead therefore to a process of continuous improvement, change and lifelong learning well beyond the content of the course.

This is a paper from ADEX (Adaptive Predictive Expert Control ADEX, S. L).

D. State-of-the-Art Remote Laboratories for Industrial Electronics Applications

The criteria of engineering qualification have demanded new skills requirements and competences that match with labor markets. The "learning-by-doing" methodology has a central role in allowing students to strengthen the understanding of the scientific concepts and phenomena, through practical sessions and thus, to be familiar with the instruments and the industrial real-world. There is no doubt that the implementation of practical sessions in engineering education paves the way for students to be familiar with the instruments and thus, with the industrial real-world. Moreover, they augment the learning outcomes by strengthening the understanding of scientific concepts and theories. Unfortunately, there exists a wide gap between the engineering educational curricula and the industrial real-world owing to the lack of experimentation availability. This is due to high cost and administration burdens that have hindered the adoption of practical sessions causing a significant decline in experimentation within engineering education. Recently, with the advent and exploitation of computer and communication technologies, remote laboratories have broadly proliferated among many universities. Remote laboratories are those laboratories that can be controlled and administrated online. They differ from the virtual simulated laboratories as they are interacting with physical instruments. Remote laboratories provide on-line ubiquitous workbenches unconstrained by either temporal or geographical considerations and allow an interactive learning environment that maintains student attention.

In this context, hundreds of remote laboratories for industrial electronics applications have been developed and numerous technologies have emerged in order to facilitate their construction and implementation. However, their design has not received too much attention; most of the published literatures focus only on the objectives of a certain application,

within a conducted course or on their functional and operational aspects, rather than their design and development. This paper reports on state-of-the-art remote laboratories for industrial electronics applications classifying their main components; the user interface, the web server, the lab server, the controller, and the object under control. The paper addresses many solutions along with cutting edge technologies involved in each component development. Moreover, several critical issues in remote laboratories construction are addressed such as choosing lab server software and client-server communication technologies. This is in order to foster remote laboratories adoption and hence, increase the industrial competencies in engineering education.

This is a paper from the UNED (Spanish University for Distance Education).

III. Conclusion

The PAC Project is an innovative approach that answers the demands of the European Higher Education Area (EHE) and adapt with the new requirements of the labor market, by promoting the integration of industrial real world requirements and labor market into the competences of bachelor degree graduates. This is in order to prepare qualified professional engineering profiles based on technical skills that are relevant to current and future labor market needs. The Partnerships between universities on the one hand and enterprises on the other, ensure the sustainability and the successful realization of the PAC project, especially when some of the partners the partners have had two successfully implemented projects (DIPSEIL and IPLECS), that will be deployed as a base for the development of the PAC project; the DIPSEIL course database will provide a pool of learning resources available in five languages. The PAC project, in addition, encompasses two months internship training programs for the students to realize a real-world practical training and thus, to strengthen his engineering work experiences and abilities. The implementation of the PAC project represents a significant shift from the prevailing learning methods towards innovative and feasible learning ones that emphasize the learning outcomes and focus on the acquired abilities and skills. In this paper the project presentation, objectives, and expected results are briefly discussed, classifying the role of each partner, and presenting an introduction on the contribution provided by each partner.

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