Special Session: Plovdiv University (BULGARIA) expertise and solution in Performance-centered adaptive curriculum for the needs of industry in Plovdiv region

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Abstract— **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 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, TepolSofts, which operate in the field of the adaptive performance-centered curriculum, will help us in the skills and personal competence profiles identification.**

On the first stage of the project the potential of employers' surveys will be explored as a tool for analysing the skills and abilities needed for the electronic and software engineering job positions. The right skills portfolio will be defined and the matrix of learning outcomes will be developed. The overlapping areas in the competence profiles and the higher education programmes 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.

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

I. INTRODUCTION

Following the renewed Lisbon strategy objectives, the competitiveness and innovation framework programme (CIP, 2007-2013) aims to contribute to the competitiveness and innovative capacity of the European Community as an advanced knowledge society, with sustainable development based on robust economic growth and a highly competitive social market economy with a high level of protection and improvement of the quality of the environment [Decision 1639/2006]

The Lisbon strategy suggests using all efforts to transform European education and training systems to be a world quality reference and to contribute to the development of the Community as an advanced knowledge-based society, with sustainable economic development, more and better jobs and greater social cohesion.

To meet these requirements, a team from Plovdiv University in partnership with the Spanish University for Distance Education (UNED) and several European companies have developed projects PAC [1], whose main purpose is to create an adaptive performance-centred curriculum for employment needs in sectors of control systems, electronic and IT engineering, which will support individuals in developing the right skill mix relevant to the 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 [2]. 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 the total employment. The experts with higher qualifications therefore will clearly be in the best position to take advantage of these developments.

In this paper PAC project objectives and expected results are presented. In the third section performance-centered approach in education is presented, which is the educational approach that we will use in developing PAC curriculum and learning content for the developing skills card for three job roles in Control engineering, Electronic engineering and IT engineering. In the fourth part we present the performance-centered learning content management system DIPSEIL, which will be the learning environment for the PAC curriculum implementation. In the part V we analyze the employment needs and necessary competences in the Plovdiv region economic environment. The last part of the paper is the methodology description of PAC curriculum development and skills card set-up.

II. Project Objectives and Expected Results

PAC is a project for development adaptive to business and employment needs curriculum on master degree level, applying performance support systems concept and principles for education in performance-centered content management learning system. We are going to develop complete programs on master degree level answering to: more higher education graduates are needed today, and the demands on university graduates are changed - there is a need of new skills requirements of many jobs not only in terms of formal qualifications but also in terms of detailed skills and competences. Identification of new demands for qualifications and qualifications profile development will input the business and employment into curriculum development and course design, to answer to the need of practically oriented/occupationally specific and designed for participants to acquire the practical skills, and know-how needed for employment in a particular occupation programmes - the successful completion of which usually provides the participants with a labor-market relevant qualification.

Project Objectives:

Identification of new demands for qualifications – identification of current skills needs and new requirements for competences in fibre-optic technology, control systems, electronic and software engineering. Jobs skills set-up design.

-Development of qualification profiles – knowledge, skills and competences in learning outcomes, curriculum framework;

-Development of Performance-centred Adaptive Curriculum (PAC) for qualification;

-Testing Performance-centred Adaptive Curriculum for qualification;

-Evaluation of the skills, knowledge and competences – answer the question: 'Right skills for the right job?'

Expected results:

The project aim and objectives are linked directly to: support the realization of a European Higher Education Area, promote a cooperation of universities and world of work, provide virtual mobility of students and teachers; support the development of innovative ICT-based content, services, pedagogies and practice for lifelong learning; provision open educational resources on-line and testing innovative performance-based e-learning.

III. Performance-centred approach in education

Performance-centered approach in learning and training [3] is a new innovative methodology in education exploring the concept of learning while doing a practical task. In the traditional approach to students teaching, most class time is spent with the professor lecturing and the students watching and listening. The students work individually on assignments, and cooperation is discouraged.

Performance-centered teaching methods shift the focus of activity from the teacher to the learners. These methods include active learning, in which students solve problems, answer questions, formulate questions of their own, discuss, explain, debate, or brainstorm during class; cooperative learning, in which students work in teams on problems and projects under conditions that assure both positive interdependence and individual accountability; and inductive teaching and learning, in which students are first presented with challenges (questions or problems) and learn the course material in the context of addressing the challenges. Inductive methods include inquiry-based learning, case-based instruction, problem-based learning, project-based learning, discovery learning, and just-in-time teaching. Performance-centered methods have repeatedly been shown to be superior to the traditional teacher-centered approach to instruction [4].

As a new technology, performance-centered educational systems have a strong potential to help students mastering job-related skills and to perform the task at hand with minimum support provided by others.That's why they are very suitable to be used in student's learning in a various scientific disciplines in field of engeneering education.

IV. Distributed internet-based performance support environment for individualized learning

DIPSEIL (www.env.dipseil.net/v3) is a distributed Learning Management System developed from a team in Plovdiv University (BULGARIA) and used in student's learning process in a various scientific disciplines – electronics, informatics, computer systems, communications, physics, medicine, etc. The system is used from another 5 universities in Europe, where there is distributed DIPSEIL server – Ireland, France, Spain, Austria, and Bulgaria.

DIPSEIL system is used for teaching students in an International Master's degree on Communication and Information systems offered by 5 European universities.

DIPSEIL system was used in many educational projects including such as new innovative methods for training of SME staff or company staff and training in the workplace.

DIPSEIL LMS explores the Performance-centered approach in Education. Each course in DIPSEIL system is composed from a set of tasks for performance, and the learning process is realized during student performs the given task. Content structure answers to the performance support systems requirements – the content is structured to provide individualized online access to the full range of information, guidance, advice, data, images, tools and software to permit the user to perform a task with a minimum of support and intervention by others. Each task consists of:

- task description
- task-specific training;
- reference information about a task or closely related set of tasks;
- instructions how to perform the task;
- Expert advice about a task.

Task description describes the task that the user has to perform. *Task-specific training* reduces preliminary training by helping the user to learn while performing the task. This type of training is learner-centred because the learner asks for help when he needs it to perform a task, and the help gives him the specific information that she/he requests. *Rreference information* supports the students by making immediately available information, which they previously had to memorize or look for in a book or a manual. *Instructions how to perform* include instructor-worked out examples or solutions to problems. *Expert advices* part contains specific advices on performing tasks.

For more information about DIPSEIL, please visit http://www.dipseil.net/v3.

V. EMPLOYMENT NEEDS OF THE INDUSTRY IN PLOVDIV REGION

Plovdiv is the second-largest city in Bulgaria after Sofia with a population of 338,153 inhabitants according to National Statistical Institute – 2011.

Located in the middle of a rich agricultural region, since the beginning of the 20th century Plovdiv grew as an industrial center. Food processing, tobacco, brewing and textiles were the main pillars of the industry in the past

Established industrial areas and production facilities located in favorable geographic directions about the city, determine the industry as one of the leading sectors of the economy in Plovdiv. Businesses located within the municipality for over 68% of industrial GDP in the region.

Industry is represented in almost its full range of sub-sectors. The highest proportion of production takes the food industry, beverages and tobacco, followed by:

• Metal casting, metal processing and manufacturing of machinery and equipment.

• Metallurgy

• Manufacture of chemicals, chemical products, synthetic and artificial fibers.

• Pulp, paper, printing and publishing products.

• Production and distribution of electricity and heat

• Telecommunications using fiber-optic technologies

• Electrical equipment, electronics manufacturing

• Software industry

In the economy operating close to 21,000 companies, such as micro / 10-10 employees / account for 91% small / 11 - 50 employees / have a share of 6% average / 51-100 employees / - 1% and 2% over 100 employees.

After careful analysis of the structure of industry in the Plovdiv region and considering the recommendations of Lisbon strategy to accelerate the adoption of innovations and innovative productions in small and medium enterprises we have identified the following sectors of industry Plovdiv that would need employees with specific skills in most cases in interdisciplinary nature:

• Fiber-optic technology;

• Control systems;

• Electronic and software engineering;

VI. METHODOLOGY FOR DEVELOPMENT OF PERFORMANCE-CENTERED ADAPTIVE CURRICULUM

The development of adaptive performance-centred curriculum for employment needs in sectors of fibber-optic technology, control systems, electronic and software engineering is structured with the following methodology:

1. Jobs skills set-up design - To make a successful jobs skills set-up design the following procedures must be performed:

-Filling questionnaires for the analysis of the jobs from companies partners in the project PAC

Jobs skills setup – Part 1			
General Description	**Applicant level of education**	**Job description**	**Skills and knowledge required to perform the duties of this job position**
Identifies occupation: engineer, designer, technician	Bachelor or Master degree on specific area	Main activities: Design; Coordinate; Make projects; Subordination; Personal training;	Basic skills and knowledge mandatory to perform the duties of this job (for instance, mathematics for engineering professions, certain level of language skills etc.)

Jobs skills setup – Part 2		
Applicants for this job should know/be able to:	**Additional skills and competences in interdisciplinary areas**	**Specific skills and knowledge required**
Skills and knowledge that are considered essential for the particular job positions;	Identifies what are the required knowledge and competences of the applicant in interdisciplinary areas connected with the job;	Skills and knowledge that can classify the applicant as a particularly relevant for the job position;

-For each job-role will be made a questionnaire which will examine the key competencies required for the given job.

-Job analysis will be done in a following way: Instructional designers from PU and UNED-DIEEC will interview the researchers and professionals from the industrial partners; will study the documents at the enterprises. ISCN experts will identify the necessary skills and underlying knowledge, the competences for job performing will be determined and the matrix of learning outcomes will be developed.

At the time cards are completed in 3 positions:

-Engineer - Designer - pneumatic and hydraulic systems;

-Engineer - Designer - electric management;

-Software Developer, Web Developer, Server Administrator;

The questionnaires about these job-roles can be found at: http://pac.dipseil.net [1]

Skills set of the three jobs roles identified after jobs role descriptions files of TEPOLSOFTS and INDEX 6:

- **Skill Set Strategy**

A skill set is a group of specific learning elements that a person should be able to apply within a certain job role. A standard group of skill sets within Europe is necessary due to the free mobility of workers. European countries such as the UK, The Netherlands, and France already have well-established open learning courses which support APL (Accreditation of Prior Learning). In APL the skills of students are assessed, existing skills are recognized, and a learning plan is developed to cover any skill gaps. The skill assessment is based on defined skill units and a skill profile which shows how much of the skill units have been covered.

- **Definitions**

The skill sets are based on the skills definition proposed by the DTI (Department of Trade and Industry) in the UK for NVQ (National Vocational Qualification) standards [2] and revised skill cards from other countries. It contains the following items:

- **Domain:** An occupational category. E.g. Domain = Process Improvement.
- **Job Role:** A certain profession that covers part of the domain knowledge. E.g. Job role = Yellow Belt, Orange Belt, Green Belt or Black Belt.
- **Unit:** A list of certain activities that have to be carried out in the workplace. It is the top-level skill in the qualification standard hierarchy. Each unit consists of a number of elements.
- **Learning Element:** Description of one distinct aspect of the work performed by a worker, either a specific task that the worker has to do or a specific way of working. Each element consists of a number of performance criteria.
- **Performance criteria:** Description of the minimum level of performance a participant must demonstrate in order to be assessed as competent.
- **Level of cognition:** For each performance criteria there is an intended level of cognition. At the same time this describes the complexity level of the test

questions for each performance criteria, according Bloom's Taxonomy – Rev. 2001 [3].

- **Skill Set Structure**

Using the terminology outlined in the skills definition model and including the skills identified during the demand analysis at the beginning of the project, a skills hierarchy for the job role MLearning Manager has been designed.

Domain: Control Systems and Adaptive Processes

Profession: Control Systems Engineer

Units:

U1: Communication
U2: Operation
U3: Design
U4 Control Methods and Strategies

Elements:

U3 Degree of Sensitivity and Accuracy
U2 Valve and Actuator Issues
U1.E2 Sensors Networking
U2.E1 Reliability Issues
U2.E2 Calibration
U2.E3 Functional Testing
U3: Standarisation & Norms
U4.E1: Control Methodology and Theory
U4.E3: Industrial process analysis

Domain: Electronic Engineering

Profession: Industry Controler SW Application Developer

Unit:

U1: Design
U2: Development and Tesing

Elements:

Target object analysis
Selection of Control Segments
System Design and Architecture
System Development
System optimization
Testing and Deployment

Domain: Electronic Engineering

Profession: Human Machine Interface SW Application Developer

Unit:

U1: Design
U2: Development and Tesing

Elements:

Target object analysis
Selection of Control Segments
System Design and Architecture
System Development
System optimization
Testing and Deployment

Domain: IT Engineering

Profession: IT-System Support Engineer

Unit:

U1: Hardware
U2: SW Configuration
U3: Scripting

Elements:

U1.E1: Computer Architecture
U1.E2: Hardware Networking
U1.E3: Powermanagement
U2.E1: Operating Systems
U2.E2: Security
U2.E3: Services and Networking
U2.E4: Business continuity
U3.E1:Basics of shell scripting
U3.E2:Implementation

2. Development of Performance-centred Adaptive Curriculum (PAC)

PAC workflow model – presents learning materials and curriculum. The developed curriculum will be one year and half program. Students will study core courses during the first semester – courses that we identify as basic and with equal importance and necessity for the third specializations – electronics, automation and control; and IT and software

engineering. Second semester students will study specialization courses according to the main identified directions and their preferences.

UNED and PU are involved in Program development, Course outline, syllabus, action verb list for learning outcomes for each course.

After the development of PAC workflow model Course materials will be developed and integrated on DIPSEIL. Learning materials will be open, reusable, in the form of task for performance, organized in modules and complete courses. Also adapted and developed courses from the developed curriculum will be used as well. Now we have almost 50 performance-centred courses in five languages in DIPSEIL in IT, telecommunication, microelectronic and electronics! We have the technical platform, open and easily accessible learning resources in a pool of learning resources on DIPSEIL data-base in five languages – solid base to organize different courses from available modules and tasks for performance according to the needs of a specific job place.

3. Implementation of PAC

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, and 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.

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

The PAC training of the students will be further strengthened trough 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 competences assessment will be performed by each of the employees. As key contributors to the initiative, they will present an evaluation reports which will capture the range of the outcomes desired and will give an overview, of the results and lessons learned.

VII. Conclusion

The described in this paper performance-centered approach in Education with the Distributed Internet-based Performance support environment – DIPSEIL LMS are key components for the developing of a Adaptive Curriculum for employment needs in a master's degree level.

We see the innovation in three main aspects: in the practice-based curriculum development, in the performance-centered methodology using for curriculum support and in the adaptation of the curriculum to the business and employment needs.

Practice-based curriculum development emphases on selection of content from a specific job role, curriculum structure around concepts, process as content and graduate outcomes instead of subject-based outcomes. The curriculum development requires analysis of a range of real situations on the job place in which the student will be expected to perform. In the curriculum development we select, sequence and integrate situations.

The PAC Project is an innovative approach that answers the demands of the European Higher Education Area (EHE) by promoting the integration of the requirements of the industrial real world and the labor market into the engineering educational curriculum. This is in order to prepare qualified professional engineering profiles based on technical skills that are relevant to the current and future labor market needs.

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