E-Learning and Comprehensive Education of Engineers in the EU

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Abstract—**The main education goal of future engineers learning in the modern society with knowledge-based economy is to provide them adequate skills and technical knowledge useful in their future, daily, professional activity. Their intellectual development must be comprehensive and it should last from the beginning of secondary school till the end of higher education. Besides strictly technical development which is supported by professional trainings during the secondary school and studies, as well as by the improvement of foreign languages skills (which allows to communicate in the international environment and to find their way in the global structure of employment), students need to enhance their "soft" competencies by the use of appropriate and personalized series of trainings. For many years in the European Union countries a following trend can be observed: to support this didactic process by E-learning techniques. In this context, this work is a kind of case study focused on author's experiences, collected during the work in technical (secondary and higher) education of polish educational system and during the implementation of two educational programs funded by the EU. The article outlines prospects for the possible evolution of proposed educational projects and training methods to enhance their effectiveness.**

Index Terms—**Computer based training, e-learning, EU didactic programs, technical education.**

I. INTRODUCTION

In the EU countries from many years there is an interest to support the education of future engineers by E-learning – particularly in the context of improvement of their professional and key competencies – defined by the European Parliament as,, *combination of knowledge, skills and attitudes appropriate to the situation, which all are needed for personal fulfillment and development to being an active citizen and for the social integration and employability"* [1]. The analysis of research results [2] (which strongly informs that *„information society development is achieved by the investment in R&D activities, innovation, implementation of modern technologies, as well as public services, which should lead to the improvement of life quality and simultaneously to minimization of the digital exclusion risk")* suggests that the border between the engineering education and the education of the rest of society in modern times strongly blurred – especially in recent years – years of mobile devices and social networks expansion, which influence on the social phenomena, e.g., human needs (current information, contact, *etc.*) and on services &

commerce (e-commerce), or the job market (the emergence of new professions) is becoming more powerful. The training of engineers is still focused on the maximum possible transfer of technical knowledge without proper development of their potential and other competencies. It is rightly stated that *"to the most important modern workforce competency gaps, which elimination should be supported also through education at university level, is the deficit of interpersonal competencies.(...) In the information society among many forms of work organizations, a teamwork is dominated. Thus, the high social skills are also useful for persons engaged in professions which previously did not require frequent interpersonal contacts, such as an engineer, accounting officer, computer scientist"* [2]. In the field of education the current adaptation of teaching methods to new emerging needs and changes, is therefore necessary, which may be support with the use of E-learning possibilities [3]. The spectrum of applications depends almost only from imagination, because every day brings new ideas and solutions [4],[5],[6]. Discussion on the development and vision of the E-learning role in education still evaluates [6] and will be changing during every year, but for the purposes of this study a following view is adopted: the strength is in a diversity, so by the drawing from various sources and different experiences, common front of activities can be assume. It may be a kind of skeleton, corps, with various arms and endings, which could be modified according to technical possibilities and local, cultural, religious and social conditions. It is postulated the thinking that E-learning may support the comprehensive education of engineers, not only through its use as an alternative to classic methods of learning, but also by supporting of personal development and by conscious creation of their professional life.

II. TEACHING OF ENGINEERS IN THE EU – PROGRAMS OF COOPERATION AND SUPPORT

Over the years, along with the growth of national Internet infrastructure of particular countries, a number of informal cooperation concepts appeared within the EU community and focused on development of distance learning. Established in 1991 by the Budapest University of Technology and Economics European Distance and E-learning Network – EDEN – international educational association and not-for-profit organization, was designed to establish a platform for cooperation between various institutions and individuals interested in this form of learning [7]. Nowadays, the EDEN exists with more than 200 institutional members and over 1200 members to share knowledge and improve understanding amongst

professionals in distance and E-learning and to promote policy and practice across the whole of Europe.June 15, 1987 year European Commission started oriented on the higher education – ERASMUS program [8]. Its aim was mainly to provide the feasibility and funding of staff and students exchanges between universities of the EU and candidate countries and among other the development of common study programs for universities participating in the program. After the success of the ERASMUS program in 1995 started the Socrates program (done to the year 1999) – extended on the improve of education of children, adolescents and adults and to promote the idea: *The Unity in the variety (In varietate concordia)* – tolerance of cultural, ethnic and religious diversity. At the end of realized in 2000-2007 continuation of the Socrates – Socrates II program, European Commission started (in the year 2007) current Lifelong Learning Program (which will last to the year 2013). LLP is extended among others on the support of peoples development with the use of innovation and modern communication technologies. The numbers demonstrate directly a scale of interest – over 150,000 students did Erasmus student exchanges (part of LLP) in the academic year 2005/06, and the cumulative total since 1987 is over 1,500,000 (66384 students from Poland in years 1998-2008). The LLP has an indicative total budget of €6.970 billion over the seven years 2007–2013.

For Poland a key moment in the change of educational standards was the date of 01.05.2004 – day of joining the European Union, because as a full member of the structure Poland has acquired among others rights to benefit from the European Social Fund [8] – one of the EU's Structural Funds, set up to reduce differences in prosperity and living standards across EU Member States and regions, and therefore promoting economic and social cohesion. The ESF is devoted to promote employment in the EU as well. It helps Member States make Europe's workforces and companies better equipped to face new, global challenges.

TABLE I: PRIORITIES OF PO KL

The global component includes priorities of:	The regional component includes priorities of:
Employment and social inclusion	Labour market open to all
Development of human resources, adaptation of companies potential and improve of people's health	Promotion of social integration
High quality of education	Regional human resources
Higher education and science	Development of education and competences in regions
Good governance	Technical assistance for the implementation of PO KL

Within the framework of European Union structural funds and national funds (including 11.4 mld EUR) earmarked for Poland (period 2007–2013), Polish Government started the realization of the Operational Program Human Capital (PO KL) [9]. A pursuit for an efficient development of human resources is a main target. A support from the PO KL is provided for following areas: employment, education, social integration, enhance of employees and enterprises adaptation potential, as well as for areas related to creation of efficient and effective public administration at all levels and for implementation of good governance principles. Human Capital Operational Program is carried out within X priorities (Table I).

Later in this paper the attention is focused on two specific didactic projects implemented under the PO KL priorities:

1) Priority IX: *Development of education and competences in regions*,

Activity 9.2: The increase of the attractiveness and quality of technical learning,

Project: "The Time for Professionals - The improve of education quality in Poznan's secondary schools" [10],

2) Priority IV: *Higher education and science*,

Activity: 4.1 The increase and development of the university's didactic potential and the increase of courses graduates number in key important studies for knowledge-based economy,

Project: "The Era of Engineer: Extension of the growth potential of Poznan University of Technology (PUT)" [11].

III. CHARACTERISTIC OF EDUCATIONAL PROJECTS

A. The Time for Professionals

Time range: 1.11.2009 – 1.08.2011

Goals of the project:

1) Enhancement of secondary school students capacity for future employment in professions: electronics technician, computer science technician, logistics technician and mechanics technician, by providing modern, interactive didactic materials for four groups of technical schools in Poznan.

2) Enrichment of the didactic schools offer through the implementation of modern teaching methods (with the use of distance learning).

3) Increase of 24 teachers professional qualifications in technical subjects by the use of Moodle courses.

4) Effective prepare of students for external professional exams.

5) Increase of students ability to searching of work on the local market.

"Hard" results of the project - 225 students increased their personal qualifications by the participation in additional, professional activities and technical subjects. These students have used educational materials placed on the didactic platform and they were involved in vocational/educational workshops.

"Soft" results of the project:

1) Increase of the secondary school students motivation for learning in professions: electronics technician, computer science technician, logistics technician and mechanics technician (by enhancing the attractiveness of didactic offers).

2) Increase of students ability to work in interdisciplinary teams.

3) Improvement of learning outcomes from vocational

subjects and practical knowledge of profession.
4) Improvement of communication skills.

B. The Era of Engineer

Time range: 15.08.2008 – 31.12.2012

TABLE II: SELECTED TASKS AND ACTIVITIES

Task nr	Title of task and brief description
2-5, 20	Preparation, opening and realization of strategic studies courses (Mechatronics and Power Engineering), as well as specialties: Aerial Transport, Aircraft Engines and Structural Engineering.
6-8	Preparation, opening and realization of postgraduate studies: Methods of Information in Mechatronics, Measuring Technology and Measurement of Shape Error, Industrial Robotics and Automation Systems.
10	Implementation of programs and teaching materials by the use of distance learning methods and techniques. *E-learning training subjects concerns mainly new faculties and specialties. All interested students and teachers can participate. In addition, the PUT organizes specialized classes of English in the remote formula for following modules: physics, construction, environmental protection, architecture, interpersonal communication.*
11	Enhance of the cooperation between the university and employers in practical elements of teaching (students internships and traineeships).
12	Creating the e-Recruitment platform. *For project purposes virtual platform was created. It is a bridge between the employer and the student as well as the student and the employer. E-Recruitment platform is available to all who would like to find practices, traineeships and employment. The remote technology permits also to monitor students' professional fate, and thus assess the quality of teaching.*
13	Organization of workshops in the field of the labor market. *Workshops have a traditional and remote form. They are designed for all PUT students. Yearly 400 students may increase their "soft skills" qualifications at workshops and acquire a practical knowledge, including: effective communication, assertiveness, overcoming of stress, speaking at the forum, creation their image and diplomacy.*
14	Improve of academic staff didactic competencies in order to enhance the quality of teaching.

The main goal of the project is to adapt standards of higher education to the needs of the economy, and especially to the labor market and to enhance the PUT's didactic quality (Table II). Within the project the PUT opened new courses of studies, specializations and new postgraduate studies. Students have received a new offer of placements and traineeships, as well as additional courses in mathematics and physics. For the project purposes an innovative e-Recruitment platform was also created. Beneficiaries of "The Era of Engineer" project are also PUT's teachers –

through courses, trainings, conferences, scholarships and traineeship programs in world's top research institutions they have an opportunity to enhance the quality of teaching and to build better scientific workshops. This program includes also training courses offers for the management staff and implementation of a standardized university's quality management model.

IV. ANALYSIS OF MEASURABLE RESULTS

Both of characterized programs (realized in the Poznan secondary and higher education) connects their innovation which is based on the use of remote learning techniques, obtain of external financing from the EFS and the target – comprehensive teaching of future engineers for their better accommodation on the labor market. A full evaluation of both programs effectiveness and teaching methods which were used, will be possible after the end of "The Era of Engineer" program within the next five years – when current university students will enter into full professional activity, but already today may be considered that these programs are pioneer in conditions of Polish education and some of their measurable results have already been visible – through the implementation of "The Time for Professionals" program – School of Communication (ZSK Poznan) from third place in the category of "Technical School" in the region – was classified in this year's national ranking of secondary schools (Rzeczpospolita/Perspectives) on the third place in Poland – mainly due to the high scores of final exams (the second result in Poland).

The efficient and well thought out use of the multimedia platform has contributed to the success of "The Time for Professionals" program, as well as the involvement of persons participating in this program. All ZSK students from professions of electronics technician and computer science technician were subjected to tests of their theoretical knowledge and practical skills (on the day of project's starts) by the use of Moodle platform. Then a group of them with the weakest results participated in several months educational training supported with E-learning courses and practical activities - prepared by previously trained teachers. By the work in groups students have a possibility to try and use of information technology knowledge in practical situations (they realized computer programs, promo movie, they wrote a website, built electronic circuits, etc.). Except that, they participated in education fairs and competed between groups. A multimedia didactic platform was made primarily to supervise and to formalize their activities by the use of time constraints, by allocation of individual tasks, by adaptation of difficulty level to the group possibilities and by increase of difficulty degrees in next tasks. The wide range of didactic forms and attractive multimedia side have made that the main goal – enhance of students technical skills (validated continuously by the solve of educational tasks) became a challenge for them and encouraged to work on their self.

In this paper, attention has been focused mainly on the tenth of twenty detailed tasks of "The Era of Engineer" program - currently realized. The PUT has now approximately 21 000 students studying in 10 faculties. Each of the faculties is a kind of separate administrative existence

– composed of few institutes which contain chairs and divisions. So large administrative machine supported with external institutions such as Department of Modern Languages (SJO) previously did not have a compact E-learning offer for students and candidates. Therefore, "The Era of Engineer" program has become an opportunity for changes and allows to coordinate courses scattered in many units. The aim of the task became clearer and actions have been conducted in three significant directions: to start on vocational courses offers on a global server, to select most interesting SJO courses and first of all to start interpersonal skills courses for students. After the dissemination of information to the PUT employees, there is considerable interest – currently 56 courses are implemented by teachers who have already experience, as well as by the new, just starting with remote learning (which is very promising in the perspective of next project edition). A total number of 8 courses of interpersonal skills was opened: The competence of entrepreneurial people, 7 Habits of Highly Effective People, Negotiating, Analysis of Student's Personality, Presentations, Effective Time Management, Secrets of a Good Self-Presentation, Improvement of Soft Competence.

V. OPPORTUNITIES FOR EXTENDING AND IMPLEMENTATION OF PROGRAMS IN COMMON TEACHING

Bearing in mind efforts of schools and the PUT for the realization of next programs editions, it is reasonable to use and consider following factors that should enhance the effectiveness:

1) Popularization of EDEN and ERASMUS ideas among teachers in order to exchange experiences and to extend the didactic placements offer – only by the current contact with world partner centers and effective observation of global social mechanisms, is possible and important from the perspective of engineers comprehensive teaching and from the work in international environments. It is desirable to work closely by programs coordinators at the individual didactic unit. A common front of activities in collaboration with partner centers and invaluable form of communication may provide the EDEN.

2) Adaptation of best solutions applied in the LLP program to enhance contacts with commercial companies in the field of bidirectional knowledge transfer – previously existing standard allowed for students trainings in cooperating companies, but did not provide effective feedback in the form of information about preferred areas of knowledge (what students should know before practices and how to use their experience in realization of their professional interests). It is also postulated to include companies in low absorbing them way – by the use of the PUT's didactic platform (e-Recruitment) by the Personal Department of the company, where apart from current information about proposed practices and requirements, company could publish general didactic materials about the structure of its functioning, work standards, as well as proposed projects and thesis themes,

which may connect the interests of university and company. It is the only way which may improve the cooperation and allow to adapt vocational training program to the current market situation and learning opportunities.

3) In the context of the e-Recruitment platform it is reasonable to use of solutions described in detail in [4] – e.g., E-portfolio as a didactic project and personal learning environment. The collection of projects made by the student in a portfolio over the secondary and higher education, allows to potential employer a more effectively evaluation of student as a candidate for the specific job position, than only on the basis of personal interview and documents presented by him.

In the background of the author's collected experiences appears also context of multimedia involved teacher as a guarantor of the didactic project success. This draft back of more complex research problems allows then (after the end of "The Era of Engineer" program) to formulate a research thesis and to verify it.

REFERENCES

[1] J. Szandurski, "Possibilities and limitations of e-education in the improvement of key competencies," in *Proc. of 8th Conf. The development of E-learning in Higher Education of Economics,* Cracow, Poland. 2011, CD.

[2] B. Ziółkowska, "Education towards the challenges of information society in Poland," in *Proc. of 8th Conf. the development of E-learning in Higher Education of Economics*, Cracow, Poland. 2011, CD.

[3] M. Khademi, H. Kabir, and M. Haghshenas, "E-learning as a Powerful Tool for Knowledge Management," in *Proc. of 2011 5th International Conference on Distance Learning and Education*, Singapore, IACSIT. 2011,vol. 12, pp. 40-44.

[4] I. Buchem, "E-portfolio as a personal learning environment: examples of applications in the German education," in *Proc. of 8th Conf. The development of E-learning in Higher Education of Economics*, Cracow, Poland. 2011, CD.

[5] A. Martinez, "Learning in chemistry with virtual laboratories," *Journal of Chemical Education*, vol. 80, no. 3, pp. 346-352, 2003.

[6] H. M. Babateen, "The role of Virtual Laboratories in Science Education," in *Proc. of 2011 5th International Conference on Distance Learning and Education*, Singapore: IACSIT. 2011, vol. 12, pp. 100-104.

[7] EDEN mission document. [Online]. Available: http://www.eden-online.org/introducing-eden.html

[8] European Commission. European Social Fund. LLP/ERASMUS/Socrates documents [Online]. Available: http://www.ec.europa.eu/education/lifelong-learning-programme/doc78_en.htm

[9] PO KL. mission document. [Online]. Available: http://www.efs.gov.pl/english/Strony/Introduction.aspx

[10] The Time for Professionals mission document. [Online]. Available: http://www.zsh.edu.pl/pages/display/37

[11] The Era of Engineer mission document. [Online]. Available: http://www.ei.put.poznan.pl

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