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APPRENTICESHIP CLUSTER FOR INDUSTRY READY ENGINEERS OF TOMORROW – AN APPROACH TO WORK-BASED LEARNING AT TERTIARY LEVEL

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Abstract: *The paper considers work-based learning with a focus on apprenticeship at tertiary level. It presents the origin, further development and transfer possibilities of work-based learning in the European Union by laying an emphasis on the German model of dual study as the most successful one so far across Europe. In addition, two structural versions are given and the main benefits for students, enterprises and universities are outlined. Detailed information about the current situation in education and industry in Bulgaria and Poland are provided so as to reveal the transferability potential of dual study in those countries. An alternative solution for introducing work-based learning in Bulgaria and Poland is offered for 3rd– and 4th–year university students following a bachelor degree course in Mechatronics, where its components are described in details. Respective conclusions have been drawn.*

Keywords: *work-based learning, apprenticeship, dual study, tertiary level, apprenticeship cluster.*

INTRODUCTION

Being on the brink of the Fourth Industrial Revolution, Industry 4.0, Europe faces radical challenges in relation to its workforce. The emerging cyber-physical systems, the Internet of things and cloud computing demand knowledge- and skill-intensive jobs, and therefore require well-educated and highly-skilled employees that combine excellent technical, generic and entrepreneurial competences. It holds true, most of all, for the manufacturing sector, where processes and organization have completely changed, and in particular for engineers who appear the driving force of innovation and advanced technologies

However, according to a number of EU documents (A New Skills Agenda for Europe 2016, European Semester 2016, Measuring Skills Mismatch 2015, European Vacancy and Recruitment Report 2014, Skills Mismatch in Europe 2014, etc.) there is a shortage of a talented engineering pool, which impedes the march towards Industry 4.0. The skills mismatches are staggering - 40% of EU employers have difficulty finding employees, including engineers, with the skills they need to grow and innovate, which results in hindering EU productivity and excellence. In addition, the youth unemployment, including engineering graduates, in some EU countries is very high (e.g. BG – 22%; PL – 18.1%, Eurostat).

The above situation differs across EU member states – there are some countries such as Germany, Austria, Denmark, the Netherlands and UK where work-based learning has been introduced in higher education to foster the graduation of a new generation of industry-ready engineers thus facilitating their entry to the labour market and reducing the skills mismatch in the engineering positions, and others such as Bulgaria and Poland where this concept is still under discussion at tertiary level. As a result, according to a 2015 EMEA survey, in Bulgaria "engineers" is the first on the top job list employers have difficulty filling and in Poland – the second top. Furthermore, Bulgaria has the

second highest skills mismatch in EU and PL is in the middle of the scale but still below the upper quartile.

Therefore, the project titled "Apprenticeship Cluster for Industry-Ready Engineers of Tomorrow" under ERASMUS+ KA3 Action could be considered as an optional solution to the above mentioned deficits by introducing work-based learning at tertiary level in Bulgaria and Poland.

EXPOSITION

Background of work-based learning at tertiary level in Europe

The rising demand for a closer link between study and work generates higher interest in the German model of dual study (also known in non-German speaking countries as work-based learning focusing on apprenticeship). Dual study is increasingly applied to the training of highly qualified professionals who appear a prerequisite for economic growth and innovation. In most EU member states the German model of dual study is viewed as a solution for tackling youth unemployment and growing shortage of skilled work force.

The German model could be traced back to 1960s and 1970s when a lot of new secondary schools were established thus resulting in a considerable growth of the number of school graduates. That ambitious culture of academization led to an influx of school graduates to universities. The process conflicted with the industry demand for talented young employees who were supposed to be educated both in theory and practice. To counteract academization, in 1974 the first Professional Academy (Berufsacademie) was opened in Germany as an attempt to develop a new educational model. Since the establishment of the state Dualen Hochschule Baden-Württemberg in 2009, the form of dual study at tertiary level has flourished.

The demand of dual degree courses could be visualized by the statistics of the Federal Institute for Vocational Training. Only for the period 2006-2011 the number of dual degree courses doubled, reaching its highest point in 2014 of 1500 dual study offers. This growth went along with an increase of the number of enterprises that found dual study as a successful model for creating a talented professional pool. The number of enterprises increased from about 18000 in 2004 to over 40000 in 2011. At the same time the number of university students following dual degree courses went up, respectively from about 40000 to above 60000. In 2014 more than 95000 students pursue dual studies.

Over the last years the successful German model of dual study has been adapted to other socio-economic and cultural contexts thus being transferred to some EU member states. Today it works successfully in countries such as Austria, the Netherlands and Denmark, though it is at an initial stage.

Structure and benefits of work-based learning at tertiary level

Under the term *work-based learning with a focus on apprenticeship* at tertiary level we understand university studies with integrated apprenticeship in an enterprise. Thus the link between work and study is built. To mesh university education with apprenticeship, theory and practice alternately change. We distinguish two models: the block phase model and the weekly model. Figure 1 illustrates the former, where theory and practice change cyclically – each cycle lasts 3 month whereas Figure 2 visualizes the latter where 3 days are spent at the enterprise and 2 days at the university.

No matter which model is used, work-based learning focusing on apprenticeship has its advantages that make it very suitable for bridging the gap between higher education and industry.

The following benefits for university students could be identified. They could

- gain practical and relevant experience which will facilitate their entry to the labour market and reduce the time it takes to find their first job;
- improve their employability through the gained industry-ready competence, which is one foot in the labour market;

- gain a better understanding of the workplace culture and its expectations and to acquire good work habits;
- have easier access to enterprises and vacant apprenticeship job positions;
- develop career awareness;
- strengthen their CVs;
- have good study conditions – small groups, individual support and career guidance, modern well-equipped premises;
- more easily fund their university studies by a regular monthly remuneration paid by the enterprise.

Certain advantages are related to enterprises as well. They could

- strengthen their cooperation with the world of higher education in order to improve the relevance of higher education;
- tailor engineering university education so as to bridge the skills gap, i.e. university students will be trained according to their needs;
- have easy accesses to apprentices;
- develop their own staff – in-company trainers will develop their competence as trainers and acquire new knowledge since apprentices bring new perspectives and challenges as they learn in order to deliver more successfully work-based learning and apprenticeship;
- recruit young industry-ready graduates who they have known and observed for a given period of time;
- achieve higher productivity and performance since former apprentices require less training, do better work and possess broader skills than other recruits;
- better retain their staff as apprentices are more likely to stay with that employer because they feel a sense of loyalty or commitment and higher work satisfaction.

Universities also benefit from that educational model. They could

- offer more attractive bachelor degree courses based on apprenticeship thus providing industry-relevant higher education, which will boost their competitiveness on the educational market;
- provide a high-quality curriculum and study programmes based on work-based learning so as to attract and better motivate their students;
- improve the competences of their academic staff through following the developments in workplace practices, processes, latest equipment and technologies;
- enhance the cooperation between university teachers/academic mentors and in-company trainers/mentors in order to deliver more successfully work-based learning and apprenticeship;
- improve the career guidance of their students;
- produce industry-ready professionals.

Conditions for transferring work-based learning focused on apprenticeship at tertiary level in Bulgaria and Poland

Better matching of labour supply and demand is a top priority of Europe 2020 Strategy for inclusive growth. The “Agenda for New Skills and Jobs” of the European Commission appeals for actions against the persistent mismatch and shortage of qualified professionals, particular in the STEM areas. In some “new” member states, such as Bulgaria and Poland, the talent shortage due to brain-drain and negative demographic trends hinders economic growth and foreign investments. Among the scarcest personnel are primarily engineers. The lack of a highly trained and proficient workforce causes problems for industrial enterprises creating long adjustment periods and inherently increased production costs. The recent Talent Shortage Survey 2015 of the Manpower Group indicates that about half of BG and PL employers face difficulties in filling jobs. Common reasons are: 35% lack of available applicants, 34% lack of technical competences, 22% lack of experience, 70% lack of work place competences.

The above data is confirmed by national and regional research. According to surveys undertaken by the Chambers of Commerce and Industry in BG and PL employers are experiencing difficulty in finding suitably skilled engineers. The main reasons given are as follows: ageing and shrinking of the engineering pool in this sector; young engineering recruits do not meet their expectations – lack of industry-relevant and generic skills; engineering university degrees do not meet industry needs – lack of practical and field-specific skills/experience and the application of a multidisciplinary approach, they are not up-to-date with industry and advanced technologies, insufficient depth of content; insufficient career guidance at universities; lack of cooperation between regional businesses and universities and unwillingness on behalf of most enterprises to participate in the development of university engineering curricula that best suits industry demands. In addition, local/regional authorities and social partners do not take part in planning regional labour market needs, and respectively in shaping university policies towards the provision of higher engineering education that best match today's industry skill needs.

Consequently, there is a high skills mismatch on the regional labour markets, complemented by a relatively high rate of youth unemployment and a slow pace of economic growth– on one hand, enterprises suffer engineering shortage due to lack of industry-ready young engineers, and on the other hand, universities "produce" engineers who either perform medium or low-skilled jobs or become unemployed after graduation because their competences cannot fully support the innovation-driven industry.

Therefore, there is a desperate need for deep-rooted and ongoing cooperation of different stakeholders in the education-to-work process within the respective regions so that they can communicate skills needs in the high-priority sectors, jointly develop work-based learning curricula for engineering students in order to deliver education at both universities and workplace and share experience and competences thus having available industry-ready engineering graduates, reducing skills mismatch and youth unemployment and boosting industry growth and innovation.

Alternative solution – Apprenticeship Cluster

The European project "Apprenticeship Cluster for Industry-Ready Engineers of Tomorrow" under ERASMUS+ KA3 Action provides an alternative solution to the above challenges and needs since it will provide a new VET-business cooperation structure in Mechanical Engineering with the active involvement of local/regional authorities and social partners, where all will meet and share knowledge, competences and experience to elaborate industry-relevant engineering curricula and produce qualified academic and company mentors. It will target work-based learning focusing on apprenticeship in order to engage all stakeholders in promoting and introducing this approach at tertiary level so as to bridge the gap between education and business, improve relevance of university education to the labour market needs and make available a new generation of industry-ready engineers that are able to meet Industry 4.00 skills demands and raise excellence.

Work-based learning with a focus on apprenticeship will be introduced and piloted at the Technical University of Gabrovo, BG and Politechnika Gdańska, PL under the guidance and consultancy of an Austrian university (FH JOANNEUM Gesellschaft mbH), which is highly experienced in offering dual study programmes. Those higher education institutions will be actively supported by two companies from Bulgaria and Poland which will contribute to the development of all project results. The respective Chambers of Commerce and Industry and social partners will also support the whole process. The project targets 3rd- and 4th-year university students following a bachelor degree course in Mechatronics.

The new work-based educational solution will provide the following main products:

A/ Apprenticeship Cluster in Mechanical Engineering and Mechatronics

The cluster is intended as a cooperation structure that will foster a sustainable partnership between business and higher education, supported by local/regional authorities and social partners to provide opportunities for apprenticeship in the sector of Mechanical engineering and Mechatronics. All cluster members will be able to collaborate closely together, transfer knowledge, exchange experience and build capacity so as to boost local and regional economic development. Common solutions in the area of apprenticeships will be reached within the cluster blog.

Furthermore, it will be a meeting point where university engineering students will be able to register, then choose a relevant apprenticeship position and apply for it. On the other hand, the enterprises will have the opportunity to become cluster members, advertise vacant apprenticeship positions, select and hire the best applicants. Both groups will be able to access apprenticeship required for contractual arrangements, reporting and tracking students' progress.

In addition, the cluster aims to promote the concept and benefits of WBL with focus on apprenticeship at tertiary level by providing a set of WBL best practices and conducting a seminar and a career fair.

The Cluster will comprise the following components:

- cluster members.
- a database with local/regional enterprises where they will publish vacant apprenticeship position for university engineering students and provide a list of in-company trainers/mentors responsible for the apprentices.
- a database for each cluster for apprenticeship applicants (university engineering students).
- a database for each cluster with in-university teachers/mentors responsible for the apprentices.
- a database for each cluster with projects proposals specified by the enterprises and intended to be implemented by university engineering students during their apprenticeship.
- a database for each cluster with best practices in WBL with focus on apprenticeship at tertiary level.
- a blog for discussing WBL issues and finding common solutions.
- contact details.

B/ Curriculum in Mechatronics

A new WBL curriculum and respective study programmes in Mechatronics integrating apprenticeship will be developed. They are intended for 3- and 4-year university students following a bachelor degree course in Mechatronics. They are designed to prepare industry-ready highly skilled engineers so as to facilitate their entry to the labour market thus reducing youth unemployment and bridging the skills mismatch, which will result in improved competitiveness of enterprises within the two partner regions. The above deliverables will be jointly developed by business and VET providers at tertiary level, supported by social partners, so that they can reflect the real skills demand of industry. If necessary, completely new subjects will be introduced into the curriculum while others, industry-irrelevant, will be removed. The theoretical part covered at the university and the practical part done in the form of apprenticeship in the enterprise will be implemented on a rotating basis. Digital technologies will underline the teaching methodology to be applied in the study programmes.

C/ E-Apprenticeship workshop for knowledge and experience transfer

It aims to build effective cooperation between university teachers/academic mentors and in-company trainers/mentors so as to successfully deliver WBL and apprenticeships thus exchanging knowledge and experience between the world of business and higher education. On one hand, the in-company trainers/mentors will be able to build/improve their teaching competences and generic skills and, on the other hand, the university teachers/academic mentors will be able to enhance their competences in work-placed practices, processes, latest equipment and technologies. The university teachers will teach in-company trainers and vice versa.

D/ E-Train-the-trainer Module 1

This module is intended for in-company trainers/mentors in order to improve their teaching competence and generic skills. It will cover topics such as teaching methods and tools, different learning styles, assessment methods, communication, active listening, problem-solving, etc. The module will also make the in-company trainers aware of the benefits of WBL both for the university students and enterprises. It will be delivered in the form of online presentations accessible from the web site of the project via a video conferencing communicator. Two face-to-face sessions are

envisaged at the very beginning and end of the training where the university teachers and in-company trainers will meet and establish personal contacts, play games, give feedbacks, etc. The in-company trainers will be taught by university teachers.

E/ E-Train-the-trainer Module 2

This module is intended for university teachers acting as academic mentors of the apprentices in order to improve their competences related to the specific work place. It will cover topics such as safety at work, work organization and processes, equipment and technologies, corporate culture and behaviour, etc. It will be delivered in the form of online presentations accessible from the web site of the project via a video conferencing communicator. Face-to-face sessions are envisaged as well where the in-company trainers will organize and host company tours for the university teachers so as to give them guidelines on the spot. The university teachers will be taught by in-company trainers.

F/ Apprenticeship discussion forum

The discussion forum will serve as a meeting point of university teachers and in-company trainers where they can exchange ideas, solve problems, find common solutions in order to achieve more effective apprenticeships. It will contribute to fostering their fruitful collaboration.

CONCLUSION

To bridge the skills gap (skills demanded by industry and skills provided by technical universities) in the field of mechanical engineering, in particular Mechatronics, an alternative solution has been found within the European project "An Apprenticeship Cluster for Industry-Ready Engineers of Tomorrow" (aCIRET) where work-based learning focused on apprenticeship (based on the German model of dual study) will be piloted in two technical universities in Bulgaria and Poland. The three key stakeholders – university students following a bachelor degree course in Mechatronics, enterprises specialized in Mechanical engineering and Mechatronics and technical universities will benefit from project main products – WBL curriculum and study programmes, Apprenticeship Cluster, E-train-the-trainer modules and E-Apprenticeship Workshop so as to boost the performance of engineering higher education institutions, engineering graduates, and regional industry.

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