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Organisational concept and European experiences in implementing the engineering educational system called Work-Based Learning

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ABSTRACT: Poland is currently experiencing a post-industrial era, which is also called the information technology era in developed countries. It is connected with privatisation processes that take place in Poland and with foreign capital investment flow. Such a dynamic environment places emphasis on the influencing skills of the participants involved in order to maintain positive relationships, while also adapting to the fluctuating fortunes of various stakeholders and individuals. That is why, in this type of Polish environment, the proposed engineering educational model must be sufficiently flexible so that it can easily adapt to new purposes and funding priorities. There is an urgent need to reorganise contemporary Polish engineering education. The Work-Based-Learning (WBL) model presented in this article could be considered one such solution.

INTRODUCTION

Environmental, political, organisational, technological and social factors of the global economy, as well as strong competition, create a highly competitive business environment that targets customers' needs. Furthermore, these factors can change quickly, sometimes in an unpredictable manner. Therefore, large companies, as well as small and medium-sized firms, and the public sector need to react frequently and quickly to both the problems and opportunities that result from this new business environment.

These changes are conducted as part of the new global economy and the strongly competitive environment. Several key factors created the foundation necessary for the new global economy, including the following:

- The environment that resulted from the technological revolution;
- The fairly stabilised political world that arose after the collapse of the Soviet Union;
- Moves towards a market economy by many countries (including China and Russia).

An advanced telecommunication network, in particular the Internet, has facilitated this movement towards globalisation.

One thing is certain: in this chaotic and quickly changing world, the contemporary economy, whether we like it or not, differs a lot from that which was known in the 20th Century. The industrial era belongs to the past, when wealth was estimated by the amount of material goods obtained. In the contemporary world, wealth is the product of intellectual capital and information, which have now become the central key resources.

Intellectual capital can be defined as a company's non-material assets. The core of the intellectual capital is described as a company's ability to be an effective player in the competitive world. Intellectual capital includes the knowledge transfer and the ability to implement it in the domestic conditions and is combined with the possibility of *creating* new knowledge for either the company or for use by other companies and institutions.

Intellectual capital refers not only to company staff, but also clients, suppliers, business relations and organisational structures, management, the organisation's ability to learn and self-renew. In such a situation, it becomes crucial to not only recruit the best-educated people, but also to place attention on employees' development.

Research indicates that a person is most creative and innovative when his/her professional activity is connected with the possibility for self-development, for example, by creating conditions to become a specialist by obtaining a Diploma of Engineer or Doctor given by a prestigious university. Such a situation is also confirmed by experiences gained by economically and technologically developed countries.

From the idea of the creation, management and transfer of knowledge, the concept of Work-Based-Learning (WBL) has been built. This system could be incorporated into the modern system named *constant learning*.

Work-Based-Learning can be accomplished at three levels of university education, which is based on a secondary educational system. These three levels are as follows:

- Level I: Education at the Bachelor or Engineer level;
- Level II: Education at the Masters level;
- Level III: Education at the Doctoral level.

All of these three levels are combined to create one coherent system with an open character.

DESCRIPTION OF THE BASIC CONCEPT OF WORK-BASED LEARNING

The concept of Work-Based-Learning (WBL) has been elaborated on in the UK and implemented with positive results by a non-governmental organisation called the *Scottish Centre for Work-Based Learning* (SCWBL), a satellite centre of the UNESCO International Centre for Engineering Education (UICEE) [1]. The SCWBL is based at Glasgow Caledonian University of Technology, Glasgow, Scotland, UK [2].

WBL has also been adopted by universities and other vocational higher education institutions in Europe, including Scotland, England, Wales, Germany (five universities), France (two universities), the Netherlands, Denmark, Sweden, as well as in the Czech Republic and Hungary. Altogether, WBL has been implemented in 15 countries in Europe; indeed, everywhere where non-governmental organisations that have contracts signed with universities, companies and employment agencies operate.

Such a non-governmental organisation is mainly responsible for the following:

- Recruiting candidates who seek to study;
- Signing contracts with employers who want to train such volunteers;
- Signing contracts with universities that wish to educate in the WBL system;
- Designing course structures;
- Evaluating students' progress;
- Managing finances.

Academic courses have mainly two-steps:

- That which is accomplished via a *distance learning* system;
- That which is achieved by a *face-to-face* system.

Graduates can obtain the following degrees:

- Level I: undergraduate - Bachelor of Science/Bachelor of Arts and, in some countries, Engineer degrees;
- Level II: postgraduate - Master of Science or Master of Arts;
- Level III: Doctor - PhD or DSc.

Academic lectures are designed and accomplished in a way that a student can also obtain a Euroengineer Diploma.

THE WBL MODEL SUGGESTED FOR THE POLISH ENGINEERING EDUCATIONAL ENVIRONMENT

A model suggested for the Polish engineering educational environment is illustrated in Figure 1, with the division of education modules detailed in Table 1. In order to explain the key features, it must be stated that this model refers to university studies conducted on a basis of examination for the secondary-school certificate. A candidate who wants to study at a university has to choose between two university educational systems, namely:

- The vocational educational system, which averages three years of study;
- The academic educational system, which usually involves two years of Master's degree studies and doctoral studies.

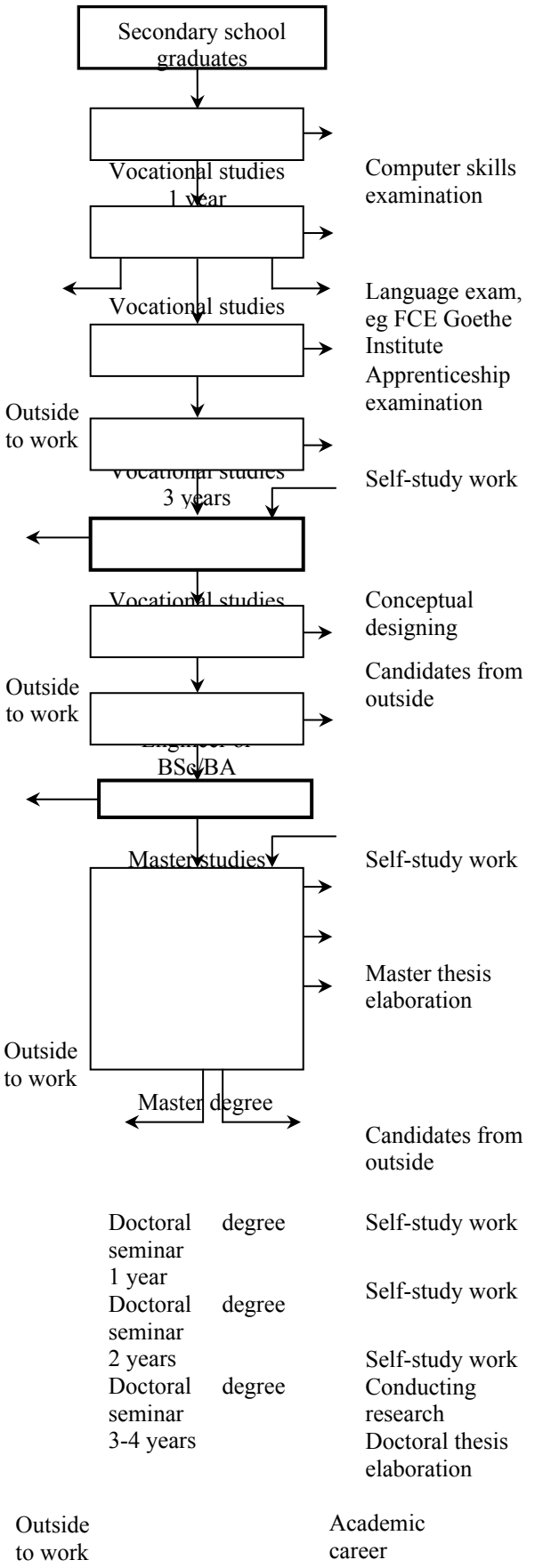

Figure 1: A model suggested for the Polish engineering educational environment.

Table 1: A model suggested for the Polish engineering educational environment by module.

Education Modules	(hours/weeks)	
	At University	In Professional Work
Computer skills; Foreign languages; Compulsory courses.	20	20
Examinations		
Foreign languages; Preparation for apprenticeship examinations; Compulsory courses.	20	20
Examinations		
Basic and specialisation courses; Pro-seminar diploma lectures.	16	20-30
Examinations		
Specialisation and elective lectures; Diploma seminar; Thesis elaboration.	12 8 (self-study work)	20-30
Final examinations		
Specialisation and elective lectures; Pro-seminar diploma lectures.	10-12 4 (self-study work)	40
Examinations		
Specialisation and elective lectures; Master diploma seminar; Master thesis elaboration.	8-10 8 (self-study work)	40
Final examinations; Master thesis defence.		
Methodology of scientific research; Elective lectures; Self-study work.	8-10 8 (self-study work)	40
Formulation of research problem; Choosing a professor to supervise a degree.	8-10 8 (self-study work)	40
Start doctoral studies; Conducting research; Doctoral examinations; Doctoral thesis defence.	4 12 (self-study work)	40

The concept described in this article deals with the system of vocational higher education.

Those candidates who want to study in the vocational higher educational system based on the WBL system must have a secondary-school certificate.

Those candidates who have passed the examination for the technical secondary-school certificate could also be exclusively accepted, but only under the following conditions:

- Good knowledge of a foreign language;
- Good computer skills;
- Good knowledge of physics;
- Good knowledge of chemistry;
- Good knowledge of mathematics.

After finishing a first year of vocational studies, a student should obtain a certificate that will prove computer skills at an advanced level. This certificate should only be awarded if a student has passed a computer examination in a computer factory, eg Microsoft.

After a second year of studies, a student has to pass a language examination according to standing rules: ie First Certificate Examination in English or the Goethe Institute Examinations in German. After a second year of studies, a student should also gain practical qualifications in order to be well prepared for an apprenticeship examination. This is why, after completing a second year of studies, a student can give up further studies and start a professional career.

The assumptions of such a system are a parallel combination of studies and practical training in different production or service departments in different companies.

The practical part of the vocational higher education system can be accomplished at two levels, as follows:

- *Level I:* professional education that enables a student to obtain apprentice qualifications. Education in this part is mainly based on manual training and is conducted during the first two years of study.
- *Level II*: professional education that leads to gaining the knowledge and qualifications required for managerial positions in a small or medium-sized company. This solution eliminates the weak points in current engineering educational systems: the lack of practical training. It must also be stated that, although public technical universities include 16 weeks of a practical training programme in their teaching, students play only passive roles.

The principal task is that courses offered by technical universities in WBL should meet the demands of the market economy and the changing political and educational environment. The transition process and restructured industries require graduates (managers) who are well trained, have good business and engineering backgrounds, can manage complex organisations and are capable of making difficult decisions within a more entrepreneurial environment.

For example, there is a demand to introduce the following study specialisations:

- Measurements and medical devices;
- Industrial measurements;
- Management of quality;
- Engineering standards;
- Management and telecommunications engineering;
- Engineering of mechanical and electro-mechanical systems;
- Audiotechnology in electronics and multimedia;
- Toxicology and engineering ecology;
- Engineering manufacturing systems in electromechanics and the electronics industry;
- Engineering of food production processes;
- Biotechnology;
- Innovation management and entrepreneurialship;
- Software engineering;
- Tourism management.

These are only some of the examples of specialised courses that can be offered in a Work-Based Learning system. They are described to illustrate that there is a strong drawback from contemporary courses and specialisations.

These changes are aimed at an integration between traditional and modern knowledge and also of an integration between current courses and specialised courses. It could be clearly stated that Poland is now experiencing a so-called post-industrial era, which is also called the information technology era in developed countries. This is connected with privatisation processes that are currently taking place in Poland, as well as with foreign capital investments.

Such a dynamic environment puts emphasis on the influencing skills of the participants involved in order to maintain positive relationships, while also adapting to the fluctuating fortunes of various stakeholders and individuals. This is why, in the present Polish environment, the proposed course structures must be sufficiently flexible so that they can easily adapt to new purposes and funding priorities [3].

CONCLUDING REMARKS

Many universities and professional bodies throughout the world have recognised the challenges from combining the practical method of teaching and the theoretical way of teaching, and are engaged in major overhauls of the way in which they educate their engineers. This includes the UK, Australia and the USA [4][5].

There has been widespread agreement that the engineering science approach, which has provided graduates of high technical ability for over 50 years, should be re-examined in light of the needs of the 21st Century [6]. Additionally, if engineers are to appreciate fully their role in society as a whole, then there needs to be more than a course on the engineer in society. Engineering education must become more outward looking and more attuned to real concerns and communities. Educational systems should promote an environmental and economic global awareness, problem solving abilities, advanced information technology skills, self-directed learning and life-long learning communication, management and teamwork skills.

For engineering and management graduates, it is crucial that, in order to play a more effective societal role, they must be better communicators. This means that they have to learn the ability to explain technical problems, and be politically and socially aware so that technical decisions can be made, understood and communicated with sensitivity. This is especially relevant across cultural boundaries [7].

Web-enabled learning resources have a critical part to play in *distance learning* systems and in creating an engineering culture.

In the current Polish engineering educational system, it has been proven that graduates from extramural studies and university extensions have fewer chances for better postings than their colleagues from intramural studies. The main reason for this is the lack of appropriate knowledge and practical experience. There is an urgent need to reorganise contemporary Polish engineering education [8]. The model presented in this article may provide one of the solutions.

Traditional methods to eliminate the high Polish unemployment rate do not solve the situation and do not recognise the real problems. The illustrated educational model gives *a fresh look* at current problems and ensures social advantages.

Additionally, the presented model may help graduates to fulfil the requirements that employers demand from them: managing technology implementation skills, problem-solving abilities, communication skills and effective project management skills. This project offers big opportunities for Polish engineering education.

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