The role of technical education in knowledge based economy

Bagieńska A.
Bialystok Technical University, Faculty of Management
Bialystok, Poland

The success in contemporary economy relies on the company's competitiveness, its fast development and the implementing of new technologies. The development of a knowledge-based economy requires appropriate human recourses. Two approaches to the concept of human capital can be noticed in the literature on the subject matter. First, the accumulation of human assets directly generates economic growth. Second, human capital, a significant factor in economic growth, has an impact on creating innovations and implementing new technologies.

There is a growing demand for highly qualified and competent employees, called knowledge workers, in the modern economy, known as the knowledge economy.

The demands of the European labor market indicate a constant deficiency of engineers. However, a graduate of a technical university should have a wider range of qualifications than up to this point. Engineering education should have an interdisciplinary nature and should combine technical content with social and humanistic content. The knowledge-based economy poses new challenges to the process of education, especially at a higher level. The aim of this work is the analysis of the structure of employment and education of students in the scope of exact sciences and technology in different countries and the specification of the qualities that a modern engineer should have.

Concept and qualities of knowledge-based economy

A knowledge-based economy is an economy in which knowledge is the main resource and factor for development. This is an economy using knowledge, creativity, and technology to produce products and services. The key to the realization of this goal is innovation [5].In a knowledge-based economy, economic development does not depend on several economic sectors but on all sectors that must intensively use knowledge in processes of production and rendering of services. A knowledge-based economy can be considered using the macroeconomic approach and the microeconomic approach. From the macroeconomic point of view, it can be accepted that a knowledge-based economy has the following qualities:

4. widespread use of new technological and organizational solutions, particularly those related to the acquisition, processing, accumulation, and use of information serving innovation; practical utilization of new technologies and their development requires the appropriate knowledge base of employees;

- a developed higher education and research and development unit sector as well as implemented mechanisms and institutions that make it possible to use the created knowledge in the entire economy [8].Graduates of technical courses of study are of special significance in the modern economy, because, firstly, they are responsible for the creation of new solutions, and secondly, the utilization and service of new technologies requires the appropriate staff.

Human resources in science and technology in OECD countries

Human resources in science and technology (HRST) are defined as persons having graduated at the tertiary level of education or employed in a science and technology occupation for which a high qualification is normally required and the innovation potential is high. Human resources in science and technology (HRST) are major actors in innovation. Science, technology and innovation, together with high-quality education and lifelong learning, are essential to turn Europe into a leading knowledge-based society, thus creating the right conditions for long-term prosperity.

In most OECD countries, HRST occupations represented more than 25 % of total employment in 2008.(fig.1) The share was even larger in Sweden (39,6 %), in Denmark (39,1 %), in Norway (38,0 %), and 34,2 % in Finland. but also in Australia (35,8 %), Canada (35,5 %) and the United States (32,3 %). Over the past decade, HRST occupations increased more rapidly than total employment in most OECD countries. In services, the average annual growth rate has always been positive, ranging from 1,1 % (in the United States) to 6,3 % (in Spain).

High-tech knowledge-intensive services and high-tech manufacturing are the two subsectors of greatest importance for science and technology in terms of generating relatively high added value, providing new jobs and contributing to competitive growth. In EU27 was 2 million employment in high- tech sector and 5,7 million in high-tech knowledge services in 2010.

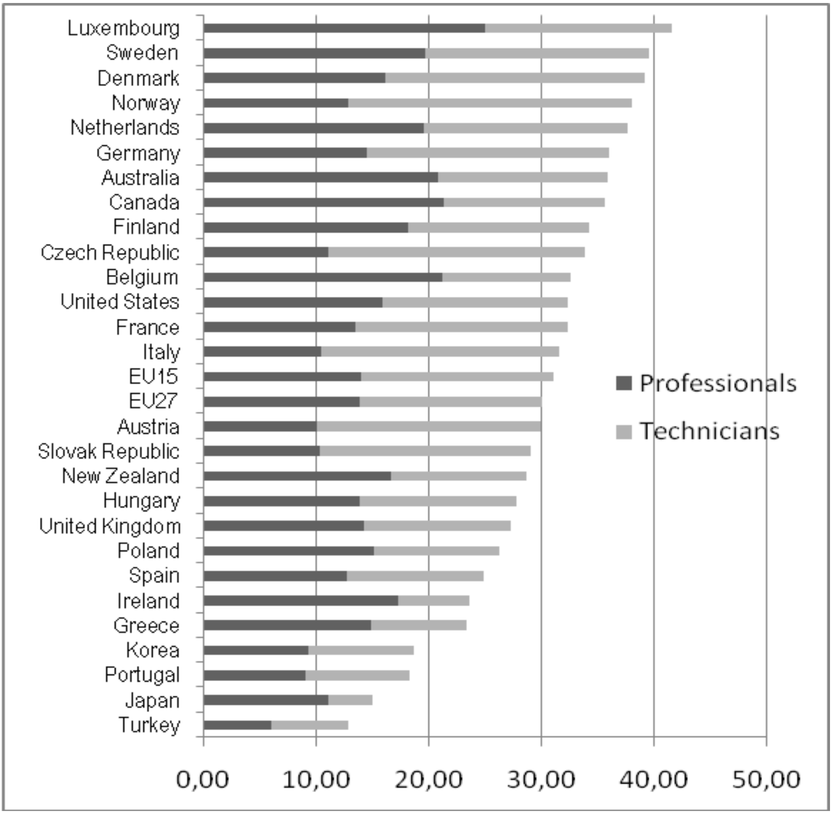

Fig. 1. HRST occupations in 2008 as a percentage of total employment Source: OECD Science, Technology and industry scoreboard 2009, OECD 2009

In the EU-27, the HRST population increased at an average rate of 2.8 % a year between 2004 and 2009. In 2009, HRST by virtue of education (HRSTE) accounted for 28.8 % of the active population aged 25–64 years in the EU 27. Finland had the largest proportion of HRSTE (41.3 %), followed by Norway (39.9 %), Ireland (39.9 %), Belgium (39.2 %) and Estonia (38.2 %).

S&E Education

The student population grew on average by 4,2 % between 2003 and

2008, but the number of students in S&E rose more slowly (3,3 %). In EU 27 students S&E (science, mathematics, computing and engineering, manufacturing and construction) was 24,3 % of all tertiary students in 2008. Finland had the larger proportion of S&E students (35,9 %), followed by Portugal (29,8 %), Spain (27,6 %). At EU level students S&E was representing 7,3 % of the population aged 20–29 years.

In this group the share of students engineering, manufacturing and construction of all tertiary students in 2008 was larger in the same countries: Finland (24,9 %), Portugal (22,3 %), and also in Slovenia (18,1 %), Lithuania (18,0 %).

Graduates in mathematics, science and technology per 1000 of population aged 20–29 was 20,2 in France, 20,0 in Romania, 19,0 in Finland and 18,5 in Lithuania.

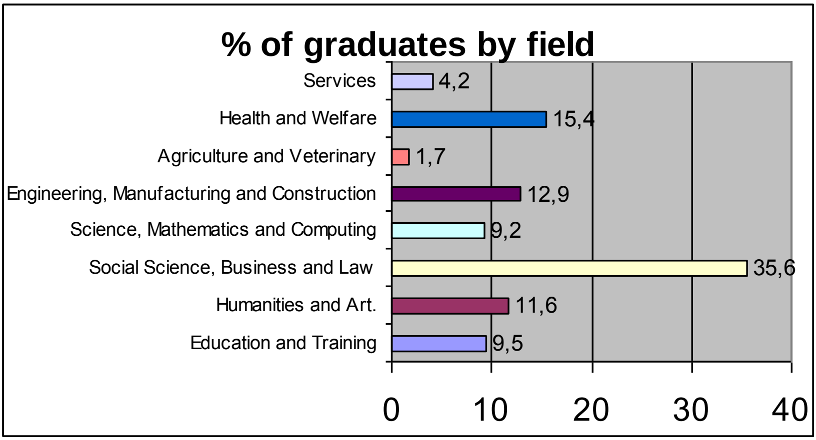

Fig. 2. The share of graduates in EU27 by field in 2008 (%)

Source: P. Mejer. P. Turchetti, E. Gere, *Trends in European education during the last decade*, Eurostat Statistic in focus 54/2011

In 2009 around the 35 % of graduates at tertiary level graduated in subjects such as social science (economics, political science and psychology) business study and law. Heath and welfare (for example medicine, pharmacy and nursing) was the second biggest group with more than 15 % of graduates. Engineering, humanities, education and science/math account for around 10 % of graduates each.

In the EU the numbers of student graduating in math, science or technology subjects had increased more then 39 % during the decade 2000 to 2010. In the some countries there were particularly high percentage changes – Romania (294 %), Slovakia (228 %), Czech Republic (144 %), Malta (130 %).

China awarded 300,000 bachelor's degrees in the natural sciences and 700,000 in engineering – together representing 43 % of its 2.3 million total in 2008. China's engineering degrees were about 10 times the U.S. number and represented a much higher share of all bachelor's degrees (30 %) than in the United States (5 %). In the other countries- Japan, South Korea, Taiwan, France, Germany (fig. 3) the number of engineering degrees was about from 70000 to 100000.

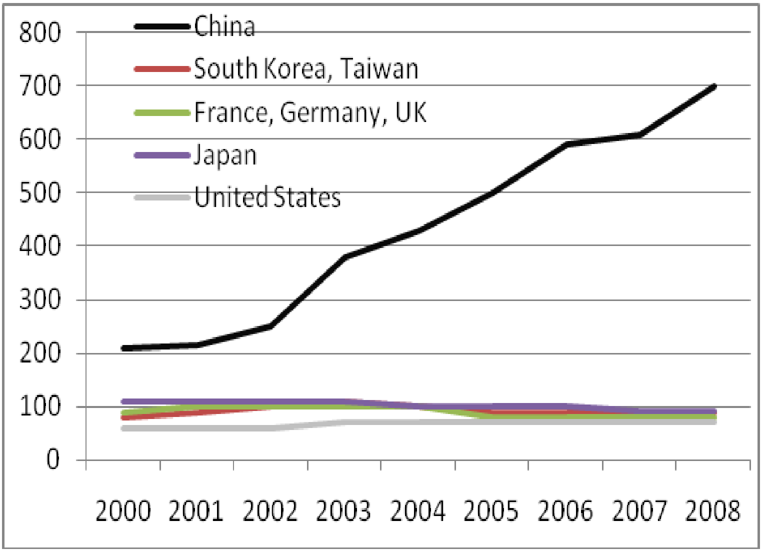

Fig. 3. First university degrees in engineering in 2000-2008 (in thousand)

Source: Science and Engineering Indicators Digest 2012, National Science Foundation, 2012, s. 11.

The number of degrees by all field between 2000 to 2008 rose more rapidly then engineering degrees also in China (356 %) and Germany (81 %), Poland (55 %) and Italy (54%). Whereas in France engineers degrees increased rapidly than all the fields. (table1)

Table 1. First university by selected country (in thousand)

First university degrees/ Country	All fields			Engineering		
	2000	2008	2008 /2000	2000	2008	2008 /2000
Canada	127	181	143	9	13	144
China	495	2256	456	212	704	332
France	275	287	104	34	41	121
Germany	178	322	181	36	40	111
Italy	150	231	154	27	34	126
Japan	538	555	103	103	95	92
Poland	207	321	155	24	35	146
United States	1254	1580	126	59	69	117

Source: Science and Engineering Indicators Digest 2012, National Science Foundation, 2012, appendix, table 2–33

Human capital employed in science and technology can not only be an indicator for the development of the knowledge market but also one of the factors for development. The structure of education should meet the demand for highly qualified specialists and engineers.

What engineers does the knowledge economy need ?

In the modern economy, a graduate of a technical university becomes a knowledge worker with a high level of specialized knowledge acquired through education or experience. The task of a knowledge worker is to create pioneering solutions in the fields of production, organization, and technology. Knowledge workers are characterized by creativity, tolerance for diversity, openness to changes and challenges. They have the awareness of a need and necessity for constantly raising their qualifications [2]. In the modern economy, qualifications and competency gained mainly through education and experience are the basis of worker development. P. F. Drucker notes that knowledge workers become the carriers of capital, not work, as was the case up to this point. In relation to this, the requirements of the labor market towards a graduate do not only pertain to his knowledge but also to other qualities necessary for creating knowledge and cooperation in a team [3]. A study conducted in Poland among employers on the subject of qualities and abilities required from a graduate shows that employers perceive three areas requiring improvement: basic abilities for a given position and profession, personal and team abilities, that is, an enterprising, not a passive, attitude, independence at the position at work, the capability for cooperation with others. Studies conducted in Germany pertaining to the system of education of engineers also indicate on a lack of certain abilities and knowledge required in modern enterprises. These studies show, that in the scope of ability and knowledge about the development of products, there is a lack of knowledge from the field of methods of product development and planning, customer-oriented thinking, design abilities, and knowledge on costs and cost management methods in higher education.

The role of institutions of higher learning in preparing the modern engineer.

I propose to use the model of interdisciplinary education in technical science which indicates the need of connecting knowledge from the speciality field with the method and practice of engineering work and with knowledge outside of the field of the speciality. Technical education must also be related to practice. Students gain theoretical knowledge from lecturers, but they should learn to apply this knowledge from practitioners. Constant cooperation of the university with various firms is possible, and some classes may take place at a firm. The student, university, and enterprise all benefit from such cooperation. For example, firms employ the best students without sustaining recruitment costs and simultaneously create a good image for their firm. Students compare their knowledge with the demands of the market and gain experience and certificates. Lecturers increase the attractiveness of classes, they have the possibility to compare their theoretical knowledge with the demands of the market.

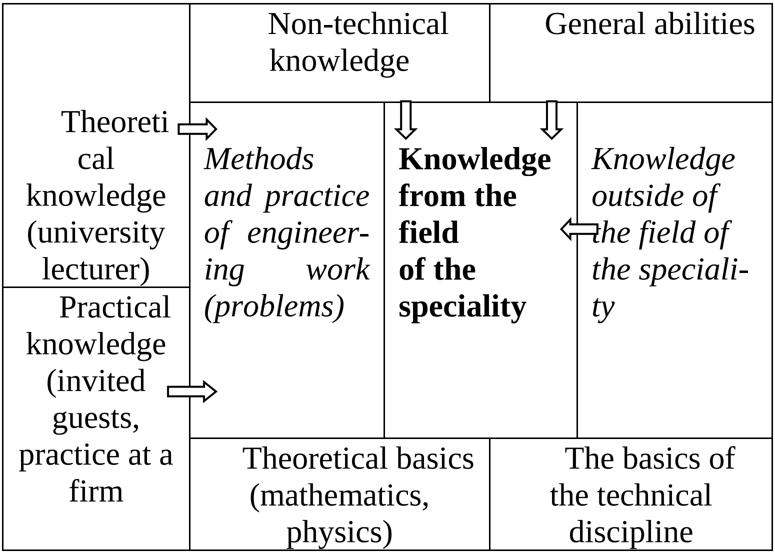

Fig. 3. Model of interdisciplinary education in technical sciences
Source: own work

This model also indicates that there is the need and possibility to create new field of study because technical education is not sufficient in the modern industry.

In Bialystok Technical University faculty of Management offers field of study – management and production engineering with specialties – eco-engineering and modern technologies management. A graduate in management and production engineering possesses interdisciplinary knowledge which is a combination of engineering preparation with managerial skills.

In knowledge based economy the quality of engineering education needs to be improved and the education must develop problem solving skills, teamwork abilities, communication skills, abilities of implementing innovations to manufacturing processes. The young people in primary and secondary education should be encouraged to study science and technology. The science should be presented in a modern, practical and attractive manner. Engineering needs to be communicated in a positive and inspiring way. Positive attitude towards lifelong learning (LLL) should be nurtured during education.

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