

GLOBALIZATION AND ENGINEERING EDUCATION: PREPARING STUDENTS FOR THE 21st CENTURY PROFESSIONS IN SCIENCE AND TECHNOLOGY

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The Globalisation influences job market in several ways: it has brought forth new opportunities and has produced some threats and uncertainties for business in general and for technical professionals in particular. In the knowledge-based society, the life cycle for technical skills is becoming shorter. There is also the problem of international recognition of qualifications, which is essential to the increasing of the mobility of technical specialists between countries. Technical professionals must keep abreast of the general globalisation trends. Engineering education is rapidly evolving as the pace of technological innovation in society accelerates. The complex global environment requires excellent technical skills. On the other hand, the global job market needs interdisciplinary knowledge and cross-functional and intercultural teamwork skills. Educators must take every advantage of both traditional methods and new approaches to engineering education. One efficient way to provide multidisciplinary engineering education – an essential aspect of modern society development – is to incorporate interdisciplinary approach into academic programs; this approach is aimed at the intellectual fusion. The multidisciplinary program is notable for integrating general studies, i.e., humanities, social sciences, management, languages, with professional studies.

Keywords: globalisation, engineering education, interdisciplinary approach to learning

1. Introduction

It goes without saying that the trend of globalisation is accelerating. Globalisation is fuelled by continuous evolution of telecommunications and transportation technologies, and the technological environment is constantly changing. Some scientists say the rate of technological progress in the last few decades can be compared with that of the last 5000 years. Engineering education is rapidly evolving as the pace of technological innovation in society accelerates. The information revolution has focused considerable attention on educational needs relative to information science and engineering.

Globalisation has re-landscaped the global environment. The economies of the world are increasingly becoming interdependent as companies expand their operations and marketing throughout the world. In this global corporate environment, technical professionals are required to work as part of international teams and devise solutions, which will be implemented across national and cultural boundaries. This new environment forces technical professionals to consider the implications of their solutions in the context of other's national interests. To be competitive in this environment, engineers must gain an appreciation for the need to understand other cultures during their undergraduate education.

Globalisation trends influence the job market in several ways. The globalisation of jobs is inevitable. More and more U.S. and European companies are moving some of their basic operations to other countries. The jobs, which are moving overseas, are both lower-level engineering jobs (e.g. computer programmers) and higher-level engineering jobs (e.g. aerospace engineering jobs, computer chip makers, etc.). We should bear in mind that globalisation has brought forth not only new opportunities; it has also produced some threats and uncertainties for business in general and for technical professionals in particular. In the knowledge-based society the life cycle for technical skills is becoming shorter. There is also the problem of international recognition of qualifications, which is essential to increasing the mobility of technical specialists between countries.

2. Globalisation and Engineering Education

It is clear that technical progress stimulates economic growth and the development of modern society is directly related with the quality of a country's educational system. Engineering educators and economists warn against quantifying the relationship between economic growths and engineering education; they call economic growth “a by-product of a great educational system”, and point out as follows – educational institutions cannot be great by merely serving national economic interests [1]. Globalisation is redefining the nature of engineering pedagogy. Thus, the education experts today face a new set of challenges for education in engineering disciplines. The question that engineering educators have to answer is: *How to respond to the globalisation of jobs?*

Technical professionals have to keep abreast of the general globalisation trends. Globalisation requires a flexible educational environment, which is efficient enough to support technical progress and economic growth of the country, and provide new career opportunities for technical professionals on a global scale. We need the educational environment with clear connections to the social and global contexts of the profession, which provides a broad education that will prepare our students for productive and satisfying careers in the midst of technological, social, and political changes. This new educational environment will by necessity be shaped by the dominant trends that exist in the global environment.

European educational environment is an integral part of the global educational environment, and it is also affected by the main globalisation trends. Education in Europe is now a strategic area; education is an excellent means of social and cultural cohesion and a considerable economic asset. The questions that European experts ask are as follows: *How good is European education? How to adapt it to the needs of the knowledge-based society?*

The new strategic goal for the European Union was set out at the Lisbon European Council on 23rd and 24th March 2000; the Lisbon Strategy requires the European Union to become the most dynamic and competitive knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion. In this context, the role of higher education increases drastically. Higher education plays a central role in the creation of a Europe of knowledge. Europeans currently make up 13% of the world's population. Experts warn that in about fifty years' time they will represent no more than 7%. This considerable change will result from two trends: a major increase in the age group over-65s – and particularly in the over-80s – and a reduction of at least 10% in the 15-29 age group [2]. The low birth rate in Europe coincides with an increased demand for higher education, which is expected to continue in the years ahead, firstly because of the policy adopted by certain governments of increasing the number of students in higher education, and also because new needs are emerging in relation to life-long learning.

European educational institutions operate in an increasingly globalised environment which is constantly changing and which is characterized by the increasing competition to attract and retain talent. European educational managers are now facing an imperative need to adapt and adjust to a whole series of profound changes. The question, which is particularly topical for educational managers, is the following: *Are they in a position to compete with the best universities in the world and provide a sustainable level of excellence?* European experts admit that the educational environment offered by the European universities is less attractive comparing to universities on the other continents, particularly American universities, especially when it comes to attracting and retaining the best talent from all over the world.

No doubt, the vision for engineering education to a large extent depends on the nature of the educational establishment and the mission of that institute. Though the internal educational environment in each educational organization is a unique intellectual community, all educational organizations serve the same purpose – they must prepare their students for the global job market with the need for technical professionals who have more skills to meet globalisation trends and workplace demands. European education experts emphasize that academic world has an urgent need to adapt to the interdisciplinary character of the fields opened up by modern society's major problems, such as sustainable development, risk management, etc. Unfortunately, the activities of the educational institutions, particularly when it concerns teaching, tend to remain organized within the traditional disciplinary framework.

The global job market requires excellent technical skills, so we must educate people for more sophisticated jobs. On the other hand, the global job market needs interdisciplinary knowledge and cross-functional and intercultural teamwork skills. Experts assert that technical professionalism “is not just about having technical competences, but it is also about mastering the principles of behind business, strategy, process and people” [3]. They emphasize that “industry wants university to supply literate, educated, and technically competent individuals who, preferably, have some experience working in multidisciplinary, team-based projects” [4]. The challenge for education experts is to provide students with the non-science skills required for the new global economy, without sacrificing the deep foundational knowledge, to teach them how to think across disciplinary boundaries.

Educational managers must take every advantage of both traditional methods and new approaches to engineering education. Some experts offer a set of education strategies that could be applied by educational managers to enhance engineering education:

- Active/cooperative learning (we use instructional activities, which engage students in doing and thinking instead of passive listening).
- Technology enhancement (computing resources are introduced into classroom to enhance learning by using software tools)
- Just-in-time learning (theoretical concepts are introduced when students' experiences create a demand for them).
- Curriculum integration (learning activities are restructured to build contextual connections between topics) [5].

Let us summarize the benefits that educational managers can gain from using these strategies. The world is constantly changing; in this dynamic global environment only innovative companies will stay competitive. Innovation begins with creativity. Using these strategies we can develop a favourable educational environment, where students will have an opportunity to create, to innovate, and to enhance their creative thinking and their creative potential.

Computer technologies are changing the way students learn. Computer networks offer new alternatives for creating, storing, and accessing, distributing, and sharing learning materials. They provide new channels for interaction between teachers and students, teachers and teachers, and students and students. Therefore, what and how to apply these technologies to engineering education is a great challenge for educators. Using modern computer technologies as a tool students can solve complicated problems and to acquire designing skills. Computer-based learning is gaining popularity spurred by a growing need for a life-long education in response to increasingly rapid technological and social change, a demand for non-traditional learning environments, and the overall flexibility this learning provides both the student and the teacher. Educators are now dreaming about *EducationWare* – a special educational tool, a “smart classroom”, which integrates computer-generated presentations and Web content [6].

3. Interdisciplinary Approach to Learning

Modern knowledge-based society needs professionals who can learn and analyse, dream and innovate. If we concentrate our efforts on creativity, we'll be able to succeed in knowledge-based development. Experts point out that interdisciplinary is a key to sustaining knowledge-based development (KBD), since “no single discipline can be capable of dealing adequately with the complex realities of the knowledge societies” [7]. One efficient way to provide multi- and trans-disciplinary engineering education – an essential aspect of modern society development – is to incorporate *interdisciplinary approach* into academic programs. In other words, old-style pedagogy and rote learning must be replaced by more progressive methods.

In order to become an integral part of the global environment an educational organization must revise its academic programs, and consider their relevance to the needs of the knowledge-based society. Educators recommend applying the so-called integrated approach to academic programs as a universal and common platform for studies [8]. This approach is aimed at intellectual fusion; the program must represent the convergence of disciplines and it must have stronger ties to the regional, national, and global communities, e.g. through program content, distance learning, and internship. A defining characteristic of the program should be substantial breadth and significant depth across the technical and general subjects. Multidisciplinary programs are notable for their interdisciplinary model for content and integration of topics; general studies - humanities, social sciences, management, languages - are integrated with professional studies. We tried to summarize the multidisciplinary engineering program's educational objectives and learning outcomes (see Table 1).

Table 1. Multidisciplinary Engineering Program Educational Objectives and Outcomes

| <i>Program Educational Objectives</i> | <i>Program Outcomes</i> |
|--|--|
| 1. To promote the acquisition of technical skills and knowledge as well as reasoning and analytical skills, and to help the student get integrated in the knowledge-based society | 1. Ability to use their knowledge in practice |
| 2. To provide opportunities for the engineering process activities: design, experiment, build, test | 2. Ability to design and experiment |
| 3. To encourage students' interest and to stimulate their desire for research work and innovation | 3. Ability to create and innovate |
| 4. To promote the acquisition of the non-science skills required for the new global economy and global job market (presentation skills, teamwork skills, the fundamentals of management) | 4. Ability to manage, to compete |
| 5. To prepare professionals who are able to communicate effectively in the global corporate environment and to promote language learning | 5. Ability to communicate efficiently in the worldwide community |
| 6. To encourage an appreciation for life-long learning | 6. Understanding of the importance for self-development and life-long learning |
| 7. To increase the student's capacity as producer and consumer of economic and cultural values and to encourage their appreciation for human, moral and ethical values | 7. Awareness of social, professional and ethical responsibility |

The program's educational objectives are determined by the strategic and associated objectives of the education and training systems, which were proposed in the work program approved by the "Education" Council and the Commission at the Barcelona European Council meeting, and which are aimed at the following:

1. **Improving the quality of education and training systems:** developing the skills needed for a knowledge society, ensuring access to ICT for everyone and increasing recruitment to scientific and technical studies.
2. **Facilitating the access of all to education and training:** creating an environment conducive to learning, making learning more attractive, and supporting active citizenship, equal opportunities and social cohesion.
3. **Opening up education and training systems to the wider world: strengthening European cooperation,** strengthening links with the world of work, research and society as a whole, developing the spirit of enterprise, improving foreign language learning, increasing mobility and exchanges [9].

4. Conclusion

The Lisbon Strategy, launched in 2000, requires the European Union to become the most dynamic and competitive knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion. Higher education establishments play an essential role in the creation of a Europe of knowledge, but this is also a great challenge. They operate in an increasingly globalised environment, which is constantly changing and is characterized by increasing competition to attract and retain outstanding talent, and by the emergence of new requirements for which they have to cater.

Modern technologies are making the world "smaller". Industries and businesses are becoming global. Next-generation engineering problems will address global issues, and to solve sophisticated multidisciplinary problems, future engineers must have the ability to integrate their knowledge, making connections between topics across different subjects and disciplines.

The conclusion is obvious – the way we teach technical students must change a lot. The development of an educational environment must be sensitive to changes in technology, new developments in pedagogy, and the importance of life-long learning. Educators have to provide students with a multidisciplinary engineering program that combines engineering theory, design and practice with some new non-science skills.

In a non-linguistic institute, educators have to find the balance between the general subjects (languages, social sciences, humanities, etc.) and the engineering subjects. Just as the public must know more about science and technology, engineers must know more about social sciences, humanities, management, etc. In order to educate future scientists, engineers and others, who will be involved with the development of new products in the 21st century, educational institutions must find ways to integrate an interdisciplinary approach into their academic programs, thus providing multi- and trans-disciplinary engineering education. Special subjects and general subjects must be kept in proportion to offer students a better preparation for life and work in the global environment, in which mobility is becoming increasingly more widespread and should be in reach of everyone.

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Stukalina J. GLOBALIZĀCIJA UN INŽENIERU IZGLĪTĪBA: GATAVOSIM STUDENTUS

21. GADSIMTA PROFESIJĀM AUGSTO TEHNOLOĢIJU JOMĀ

Būtisks faktors, kas pašlaik ietekmē moderno sabiedrības attīstību ir globalizācija. No tas ir atkarīgi praktiski visi aspekti: ekonomiskās un sociālās pārmaiņas, ekonomikas transnacionālais raksturs, strauja pāreja uz zināšanām balstītu sabiedrību, moderno tehnoloģiju strauja attīstība, pārmaiņas darba tirgū. Tas ved pie ekonomiskās integrācijas un darbaspēku mobilitāte. Visbūtiskākās pārmaiņas tehnisko speciālistu sagatavošanā ir saistītas ar globalizācijas tendenci. Globalizācija atnes kā jaunas iespējas, tā arī jaunus izaicinājumus. Globalizācijas kontekstā tehnisko iemaņu termiņš kļūst īsāks. Kvalifikāciju starptautiskā atzīšana arī ir aktuāla mūsdienu problēma. Turklāt modernam darba tirgum ir vajadzīgi profesionāli ar lieliskām tehniskām iemaņām un komandu darba prasmēm. Ņemot vērā iespējamās globalizācijas sekas, izglītības eksperti var izmantot jaunas pedagoģiskas metodes, ieskaitot starpdisciplināro pieeju. Tas ļauj viņiem apvienot vienā kopumā dažādu disciplīnu metodes un līdzekļi un domāt plaši aiz viņa disciplīnas robežām. Starpdisciplinārā pieeja pie izglītības nozīmē profesionālo priekšmetu integrāciju ar vispārīgāko priekšmetus – svešvalodas, humanitāro un sociālo zinātnes. Šis raksts aplūko būtiskos izglītības ekspertu izaicinājumus un svarīgās tendences inženieru izglītībā.

Atslēgvārdi: globalizācija, inženieru izglītībā, starpdisciplinārā pieeja pie izglītības

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