Transport and Telecommunication, 2007, Volume 8, No 1, 30–39
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GLOBALISATION AND ENGINEERING EDUCATION: PREPARING STUDENTS FOR PROFESSIONS OF THE 21st CENTURY IN SCIENCE AND TECHNOLOGY

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Globalisation has focused considerable attention on educational needs relative to information science and engineering. Education has become a key resource in today's knowledge-driven society. With new technologies constantly being introduced across the globe, there is an increasing need for scientific and engineering education. Engineering education is rapidly evolving as the pace of technological innovation in the knowledge-based society accelerates. In recent years, there have been essential changes in engineering education in terms of content and knowledge delivery. The quality of engineering education today is one of the main issues for the education experts. Technical professionals must keep abreast of the general globalisation trends. The complex global environment requires excellent technical skills. On the other hand, the global job market needs interdisciplinary knowledge and multidisciplinary skills. An integrated (interdisciplinary) approach toward a flexible education paradigm is gaining popularity among educators. This paper addresses some critical challenges of engineering education; it stresses the importance of creating a highly integrated and learner-centred educational environment to provide multidisciplinary education. It also describes a few learning techniques that can be applied by engineering educators for developing multidisciplinary skills.

Keywords: *engineering education, interdisciplinary approach to learning, multidisciplinary skills*

1. Introduction

Globalisation is a topic frequently discussed by education experts. The trend of globalisation is accelerating. The technological environment is constantly changing. The advances in telecommunications and transportation technologies have led to the profound changes in the global environment. Modern telecommunications networks provide the exchange of information on a global scale. Rapid technological progress leads to new products, new markets, and new knowledge. National boundaries have become more permeable to capital, goods, and skilled labour. The economies of the world are becoming more interdependent. 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. As technology becomes central to economic growth and prosperity we encounter the need to effectively teach future engineers, scientists, managers, and others, who will be involved with the development of new products and technologies in the 21st century. In the dynamic global environment of the 21st century, they are expected to meet both the technical and business expectations of their customers. With increasing globalisation, the need for engaging engineers in continuing education is increasing too.

Globalisation has focused considerable attention on educational needs relative to information science and engineering. Experts emphasize that education is a key resource in today's knowledge-driven society [1]. Engineering education is rapidly evolving as the pace of technological innovation in the knowledge-based society accelerates. In recent years, there have been essential changes in engineering education in terms of *what to teach* (content) and *how to teach* (knowledge delivery). The quality of engineering education today is one of the main issues for the education experts.

The knowledge-based society poses critical challenges to educational organizations in various aspects: pedagogical, technological and organizational aspect. An integrated (interdisciplinary) approach toward a flexible education paradigm is gaining popularity among educators, since it ensures the necessary evolution of engineering education for coping with the ever-evolving modern society [2]. Flexible education provides students with a wide variety of learning resources, and the opportunity to acquire a wide variety of skills. This paper addresses some critical challenges of engineering education; it stresses the importance of creating a highly integrated, and learner-centred educational environment to provide multidisciplinary education.

2. Globalisation and Engineering Education

The full impact of globalisation on the market and career opportunities for technical professionals goes beyond national economies. Experts call economic growth "a by-product of a great educational system", and point out that educational institutions cannot be great by merely serving national economic interests [3]. The globalisation of jobs is an inevitable consequence of the knowledge-driven economic development. The mobility of technical professionals between countries is increasing; some jobs are moving overseas (electrical engineers, programmers, etc.); the job market is expanding and becoming global. Thus, the education experts today face a new set of challenges for education in engineering disciplines. The question that is receiving much attention from engineering educators is how to respond to the globalisation of jobs?

European educational institutions operate in an increasingly global environment which is constantly changing and which is characterized by 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. Education in Europe is now a strategic area; education is expected to play a central role in achieving the strategic goal set at the Lisbon European Council – to make the European Union the most competitive and dynamic knowledge-based economy in the world, which is capable of sustained economic growth with more and better jobs and greater social cohesion. In this context, the role of higher education increases dramatically. A university degree is becoming a necessity; a bachelor's degree is not enough to ensure employment that leads to a successful career. Today, technical specialists must constantly upgrade their skills and continue their education throughout their careers in order to compete in the global marketplace.

There is one more factor, which determines the importance of higher education. Europeans currently make up 13% of the world's population. Experts warn that in about fifty year's time they will represent no more than 7%. This considerable change will result from two trends: a major increase in the over-65s – and particularly in the over-80s – and a reduction of at least 10% in the 15–29 age group [4]. So, ageing is one of the top challenges that European economies face. To make up for the population ageing, and to provide the opportunities for continuing education (life-long learning), European experts concentrate their efforts on improving the quality of the European system of higher education. Enhancing the level of participation in mathematics, science, technology and engineering studies is a way to improve the situation; it is aimed at equipping young people with the skills needed in a dynamic knowledge-based economy

European experts admit that the educational environment offered by the European universities is less attractive compared to American universities, especially when it comes to attracting and retaining the best talent from all over the world. The burning question, which is particularly topical for educational managers today, is the following: *Are European higher engineering schools in a position to compete with the best universities in the world and provide a sustainable level of excellence?*

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 comes to teaching, tend to remain organized within the traditional disciplinary framework.

With new technologies constantly being introduced across the globe, there is an increasing need for scientific and engineering education. Technical professionals have to keep abreast of the time and the main trends in the local and international markets. 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 multidisciplinary skills. Among valuable qualifiers for technical professionals are also constant self-development and intercultural teamwork. 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" [5]. 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" [6]. The critical 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. Therefore, we have to adopt a new philosophy for knowledge delivery.

For teaching students in the highly diverse and challenging global environment, educators 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 (educators 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) [7].

Let us summarize the benefits that educational managers can gain from using these strategies.

1. These new education strategies will support educators in their efforts to improve teaching and instruction so that each student may achieve at higher levels, which is the mission of all professional development [8].

2. 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.

3. This new educational environment supports the development of students' personal identities as active and capable learners who believe that learning to the best of their ability is their main task.

4. For an engineer, it is very important to update his knowledge to keep step with fast technological progress. New education strategies pay special attention to developing life-long learning skills, which is vital for technical specialists today. These strategies are intended for providing students with an education so that they can develop themselves, to their intellectual and professional growth.

5. Computer technologies are changing the way students learn; they offer a great promise to both teachers and their students. Computer networks provide new alternatives for creating, storing, accessing, distributing, and sharing learning materials. They make available new channels for interaction between teachers and students, teachers and teachers, and students and students. 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, a demand for non-traditional learning environments, and the overall flexibility this learning provides for 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 [8].

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" [9].

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 [10].

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.

The author has summarized the multidisciplinary engineering program's educational objectives and learning outcomes (Table 1). The program's educational objectives are determined by the strategic and associated objectives of the education and training systems, which are proposed in the work program approved by the "Education" Council and the Commission at the Barcelona European Council meeting, and which stress upon the following:

1. Improving the quality of education and training systems: developing the skills needed for a knowledge society, identifying new basic skills and ways of integrating them into the curricula, alongside the traditional basic skills.

2. Ensuring access to ICT for everyone and increasing recruitment to scientific and technical studies: providing adequate equipment and educational software; encouraging the best use of teaching and learning techniques based on ICT.

3. 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.

4. Increasing recruitment to scientific and technical studies: motivating more young people to choose studies and careers in the fields of mathematics, science and technology.

5. 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 [11].

Table 1. Multidisciplinary engineering program educational objectives and outcomes

Program Educational Objectives	Program Outcomes
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 encourages students' interest and stimulates 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 encourage their appreciation for human, moral and ethical values	7. Awareness of social, professional and ethical responsibility

The thorny question, which arises in connection with the multidisciplinary engineering program, is: *Can it be the panacea for all major engineering education issues?* At least, such programme can be rather efficient on condition that in the core curriculum we will find the balance between traditional engineering content and non-science skills. Besides, our students want "customized learning experience", tailored to their current needs [12]. However, without creating a flexible, learner-centred and highly integrated educational environment, where we might apply some progressive pedagogical techniques, all our efforts will be unavailing.

4. Highly Integrated Learner-Centred Educational Environment as a Prerequisite for Multidisciplinary Education

To achieve the educational objectives mentioned above we have to redefine the nature of the existing educational pedagogy, and "the changes will involve, among other things, a major shift from a teacher-lecture-centred environment to a learner-centred/learning-style environment "[13]. In a learner-centred environment, students are no longer expected to be passive recipients of knowledge, and the role of the teacher is to assist the students in constructing their own knowledge. But what features are inherent in the learner-centred educational environment?

It is the internal educational environment, which shapes the educational organization. The internal educational environment in each educational organization is a unique intellectual community. The internal educational environment comprises the internal resources of an educational organization intended for instruction and learning:

- non-human (material) resources (physical and technological environment, financial resources);
- human resources (non-material environment);
- instructional environment – teaching materials, documents regulating the learning process, etc. (Figure 1).

The internal educational environment is not a collection of separate segments, but a complex system. A complexity of the system is due to a combination of its subsystems that function together to achieve a common purpose, though the nature of these components varies greatly through the system. It represents a phenomenon, which in philosophy is called a holistic system: the performance of the whole system is not equal to the total sum of its separate unit's performance. Such system allows the involvement of gradual growth, addition or modification to an existing environment structure. To be efficient it must work as a unitary whole. A change in one subsystem affects other subsystems as well, because they are interdependent.

The components (subsystems) of the internal educational environment must be interconnected and coordinated, the higher integration between the environment components, the more effective the performance of the educational organization. Thus, if we try to manage these components independently from each other, we will decrease our potential success. The interaction between the internal environment subsystems is essential to leveraging the educational organization's resources (human, non-human, and instructional) to the greatest benefit for all learners.

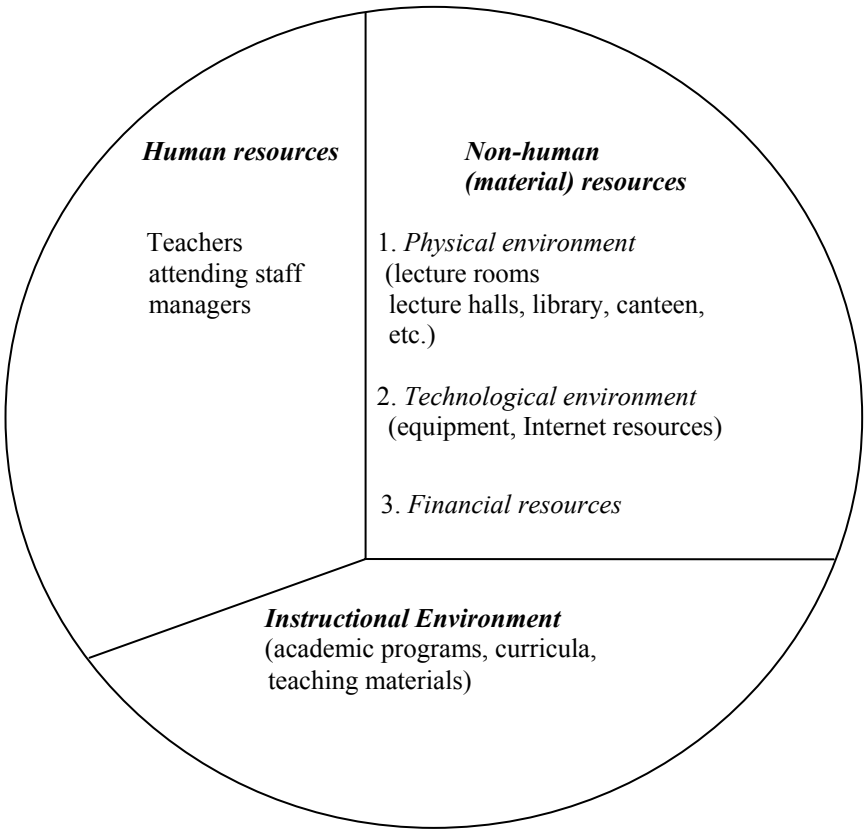

Figure 1. The internal educational environment of an educational organization

The highly integrated educational environment is always a learner-centred (student-friendly) system, since our every effort is bent to use all internal resources effectively in order to prepare students for the changing workplace where cross-functional teams are common. This objective can be achieved only in a fully integrated and well-coordinated system (Figure 2).

The collaborative environment makes it possible to adjust the instruction (and the curriculum) to student needs through constant student feedback – interviews, student surveys, one-minute paper technique, etc. Such feedback, in turn, drives the internal educational environment design, development, and improvement, and facilitates a more integrated environment creation.

Only highly integrated educational environment is appropriate for advanced studies; it allows to cohere the knowledge among classes, and to offer students the opportunity to acquire a wide variety of skills. It points on the following:

- ensuring effective and coordinated learning opportunities for all students;
- providing efficient material base;
- ensuring effective and coordinated expert and instruction support;
- ensuring collaboration proficiency and effective communication.

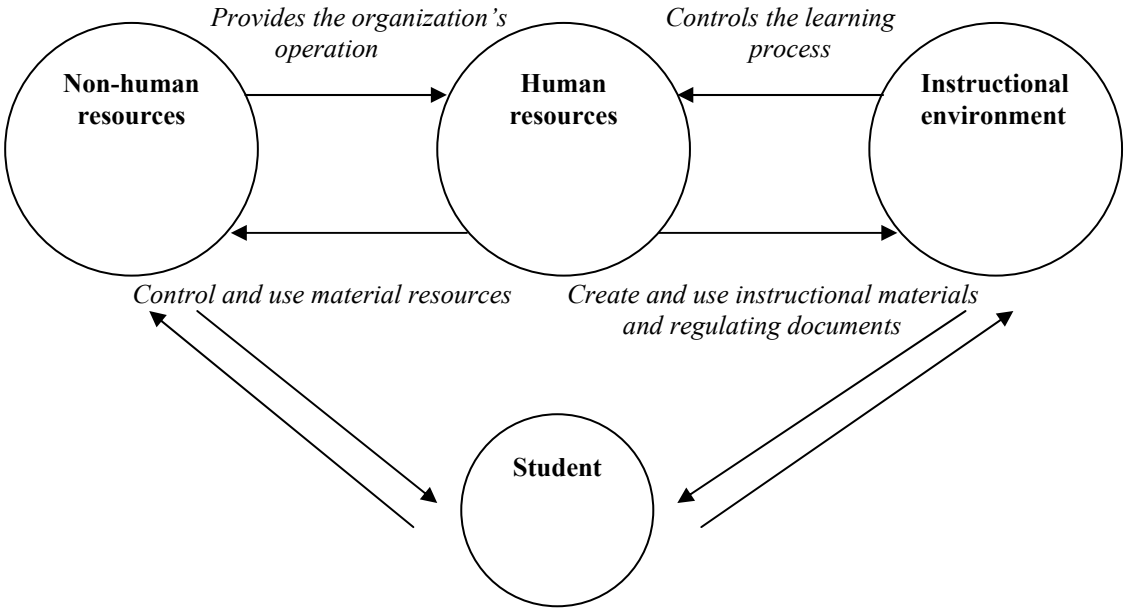

Figure 2. The learner-centred educational environment: the internal resources integration

The highly integrated educational environment as a unitary system are characterized, among other things, by interior integrity and interoperability of its units, diversity of all kinds of components across the system, adaptability and flexibility.

Being a learner-centred medium, the highly integrated educational environment is characterized by the following pedagogical aspects: arranging for interactive learning and interactive material delivery, giving students the opportunity to solve authentic problems, offering students team work combined with individual work, generating the atmosphere for critical and creative thinking and problem-solving. As a result, the integrated educational environment provides the basis for the learning process that encourages continual progress through the improvement of the multidisciplinary skills, which students have to acquire.

Thus, the learner-centred educational environment is the necessary prerequisite for the implementation of the interdisciplinary approach to studies, for this approach presupposes interdisciplinary model for content and integration of various subjects, i.e. organized and coordinated learning activities. Multidisciplinary education can only be accomplished in the highly integrated and student-oriented educational environment.

One of the major challenges encountered with the internal educational environment is the difficulty associated with the ever-changing external environment. When the internal environment is aligned with the global market needs, it stimulates the educational organization's activities, so that it can

engage students as enthusiastic, assiduous and conscious learners. It is created out of a need to prepare students both for industrial and research orientations. This flexible and more versatile educational environment allows educators to introduce new effective forms of learning and use new productive ways of organizing the learning process.

The interdisciplinary approach to learning as the basis for the learning process organization involves a variety of pedagogical tools including the elements of teamwork-based learning, project-based learning, studies abroad, undergraduate work and research experiences, etc. Future engineers need opportunities to experience the workplace; the importance of context and practice for our students is really high.

5. Developing Multidisciplinary Skills

In order to educate future engineers and scientists educators must find ways to integrate a multi-disciplinary approach into the learning process. For this purpose we may also make use of the so-called collaborative teaching: to organize multi-functional teams to work on the project. This process requires the integration of technical skills, as well as computer skills, communication skills, managerial skills, language skills (if the project involves the international aspect), etc. Teachers of special subjects help students prepare the project in cooperation with teachers of general subjects and the attending staff, and in the process use the integrated resources (material, non-material, instructional) of the educational organization.

In that way, we prepare students for the changing workplace where cross-functional teams are common, simulate an environment where students with diverse backgrounds can work together to achieve common goals, and mature their presentation skills. In other words, we develop the whole set of multidisciplinary skills necessary for professionals today, so that future engineers will acquire the ability to integrate their knowledge, making connections between topics across different subjects and disciplines to solve multidisciplinary problems.

The questions that engineering educators have to answer are as follows:

- *How to transfer knowledge from one domain to another?*
- *How to make specific knowledge adaptable to multidisciplinary problems?*

In the society, where problem-solving and multidisciplinary skills are of fundamental importance, we must integrate learning about different fields so that it agrees with the abilities and learning requirements of our students. According to T. Bentley, in order to help our students integrate and organize their realm knowledge into manageable packages, which are useful and practical, and leave space for more learning, we may use role-playing; “roles are the means by which we organize our understanding and abilities, translating what we are capable of doing into meaningful performances in a particular realm”; Bentley mentions the following roles: learner, worker, teacher, expert, leader, problem-solver, etc. (Table 2). Each role implies a certain capacity that must be developed [14].

Multidisciplinary education engages learners in performing a variety of roles, which associate to those that they may carry out in real life. In the highly integrated and learner-centered educational environment, we can provide our students with the opportunity to shape their own roles according to their learning goal orientation and the resources available to them. For this purpose, we use the inter-disciplinary education model, which allows educators to use different learning techniques and various combinations of internal and external resources for developing multidisciplinary skills. This education model embraces diversity; it is suitable for a multidisciplinary engineering educational programme realization.

In the learning process, each student is allocated a particular role/or roles, which help as follows:

- enhance their self capabilities (capacities);
- foster the acquisition of professional skills;
- encourage the acquisition of multidisciplinary skills;
- stimulate their creative potential;
- stimulate effective communication, exchange of knowledge and experience, etc.

Thus, the interdisciplinary educational model covers those learning activities, which can be carried out as different roles adapted to the learning objectives. For role-playing, the highly integrated and learner-centred educational environment provides sufficient resources (material and non-material) and opportunities (self-generated and generated by the environment), which are unified and coordinated to ensure multidisciplinary education with the emphasis on the acquisition of excellent professional skills.

Table 2. The basic learning techniques for multidisciplinary skills development

Role	Capacity (according to T. Bentley)	Learning Techniques (Interdisciplinary Education Model)
Learner	The capacity to identify one's goals and learning needs, to identify and gain access to the resources which enable one to achieve those goals, to set appropriate criteria for assessing the achievement of those goals, and to evaluate how one's learning impacts on one's understanding of other realms, and how one defines one's future goals	Interactive knowledge delivery Integrative learning Just-in-time learning
Problem-solver	The capacity to recognize, frame and analyse problems, to investigate possible ways of representing and approaching them, and to employ a range of techniques, resources and abilities in order to solve them	Project-based learning Cooperative learning/teamwork Integrative learning
Leader/Manager	The capacity to recognize and formulate goals and challenges, to motivate people to meet them in appropriate ways and to reward and celebrate achievements, both individual and collective	Project-based learning Cooperative learning/teamwork
Worker	The capacity to understand how one's abilities and energy can be employed to productive activity, developing motivation and discipline, and applying oneself creatively to finding more appropriate, productive ways of working	Technology-enabled learning Undergraduate work experiences Studies abroad/internship Cooperative learning/teamwork
Expert	The capacity to understand and develop the key components of expertise in a given realm, including the range and types of knowledge, the contexts in which they can be applied, the people and institutions which constitute the field, the conceptual frameworks and ways of thinking which governs the realm, and the unanswered questions, which are to be solved	Technology-enabled learning Undergraduate work and research experiences Studies abroad/internship
Teacher	The capacity to pass an appropriate knowledge to others	Cooperative learning/teamwork

6. Conclusions

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 global 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 word "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.

Only highly integrated educational environment is appropriate for multidisciplinary education; it allows to cohere the knowledge among classes, and to offer students the opportunity to acquire a wide variety of skills. The integrated educational environment is a collaborative medium that supports cooperative multidisciplinary learning team, and where educators can simulate real-life situations to prepare their students for the responsibilities and challenges of their future job.

In the knowledge-based multidisciplinary skills are of primary importance, engineering educators must find ways to integrate a multidisciplinary approach into the learning process. Multidisciplinary education involves learners in performing various roles, which associate to those that they may execute in real life. The interdisciplinary education model, allows educators to apply a set of modern learning techniques for developing multidisciplinary skills through role-playing, and the highly integrated and learner-centred educational environment may provide the learning process participants with the resources and opportunities, which are necessary for ensuring multidisciplinary education with the emphasis on the acquisition of excellent professional skills.

Technical students and their teachers expect their educational experiences to involve the use of the whole suite of modern learning techniques, which engage the following aspects:

- active learning;
- integrative learning;
- cooperative learning;
- interactive learning;
- technology-enabled learning;
- just-in-time learning;
- project-based learning;
- internship;
- work and research experience.

These learning techniques are aimed at the improvement of instruction for enhanced and sustained learning.

References

1. Schleicher, A. Progress in Education: Studying the Signs, *OECD Observer,* No 239, 2003, pp. 33–35.
2. Gillet, D., Nguyen Ngoc, A. V. Collaborative Web-Based Experimentation in Flexible Engineering Education, *IEEE Transactions on Education*, Vol. 48, No 4, 2005, pp. 696–704.
3. McGraw, D., & Demirel, S. My Jobs Lie Over the Ocean, *IEEE Engineering Management Review*, Vol. 32, No 1, 2004, pp. 77–80.
4. *RDT info. Magazine for European Research*, No 30, June 2001, p. 29.
5. Pan, Eric T. S. Globalisation and Your Career, *IEEE Engineering Management Review*, Vol. 33, No 4, 2005, pp. 3–6.

6. Feller, I. *The Industrial Perspective. University-Industry-Government Relations Obstacles and Opportunities: a Report by the Science and Technology Policy Program*. New York: New York Academy of Science, 1999, pp. 12–22.
7. Taylor, R. L., Heer, D., & Fiez, T. S. Using an Integrated Platform for Learning™ to Reinvent Engineering Education, *IEEE Transactions on Education*, Vol. 46, No 4, 2003, pp. 409–419.
8. Carole, E. Continuous Quality Improvement: Integrating Best Practice into Teacher Education, *International Journal of Educational Management*, Vol. 21, No 3, 2007, pp. 232–237.
9. Snow, C. Network EducationWare: An Open-Source Web-Based System for Synchronous Distance Education, *IEEE Transactions on Education*, Vol. 43, No 4, 2005, pp. 705–712.
10. Carillo, F. J. From Transitional to Radical Knowledge-Based Development, *Journal of Knowledge Management*, Vol. 10, No 5, 2006, pp. 3–5.
11. Evans, D. L., Goodnick S. M., & Roede, J. R. ECE Curriculum in 2013 and beyond: Vision for a Metropolitan Public Research University, *IEEE Transactions on Education*, Vol. 46, No 4, 2003, pp. 420–428.
12. *The European Commission Official Journal C*, Vol. 142, No 1, 14.06.2002.
13. Jones, R. C., Butcher, W. S., Chu Prey, J. The Globalisation of Engineering, *IEEE Engineering Management Review*, Vol. 33, No 4, 2005, pp. 40–49.
14. Reilly, R. Guest Editorial Web-Based Instruction: Doing Things Better and Doing Better Things, *IEEE Transactions on Education*, Vol. 48, No 4, 2005, pp. 565–566.
15. Bentley, T. *Learning beyond the Classroom. Education for a Changing World*. London and New York: RoutledgerFalmer, 1998, pp. 129–132.