

# Implementation of An Engineering Educator Graduation Program for the formation of New Skilled Engineering Teachers

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**Abstract** — COPEC - Council of Researches in Education and Sciences education team has designed a new program in graduation level: the Professional Engineering Education. The goal is to improve the formation of the engineering educator providing them with all the competencies needed to teach at the state of the art with the best available teaching technologies. The PEE Program offers two graduate degrees: the Master of Science and the Doctor of Philosophy. It is a very dynamic and rich program, developed in modules, following the trend of global formation of professionals, mainly to attend the need of a prepared engineering educator to act in the several different cultural environments, which mobility has imposed as a fact of life for researchers and teachers at graduation level. Not to mention the necessary new competencies of educators such as: evaluation management; development competencies; communication skills; teamwork; ethics and intercultural competencies. So this program has been designed to fulfill this lack of engineering educators.

**Keywords:** Education sciences, competencies, technology, intercultural skills, qualification

## I. INTRODUCTION

The education in any level is watching the deep transformation of world in every level trying to change in order to accomplish its noble mission of prepare future generations of people to work hard for the betterment of human conditions.

Engineers are one of the main agents of promotion of development in the world and the formation of a new kind of engineer is the priority to face the new world environment, which aspects are not always positive for a large proportion of humanity [01].

Engineers as problem solvers should be more aware of the impacts of any development also in social level once the impacts of unification of world in any level has consequences for the entire world. International experience shows to be one of the best ways to teach at the present conditions once mobility is higher, communications are easy and accessible for the majority of the world population.

Some educators advocate that the world as the classroom for engineers has a possibility since men started to navigate to far seas. The world has been and now more than ever where engineers can find inspiration, knowledge, employability and opportunities.

Education without any doubt is a science in constant construction like any area of men's life: dynamic, challenging and alive.

One key question of how to form the best professional is always being made and answers have been so many that it is difficult to say it is this or that. Many Institutions of Education have been seeking goes the best ways to provide high level education goes their society worldwide. Anyhow the quality of the Institutions of Education implies several aspects such as the: quality of classrooms, labs, libraries, communication systems etc; students ' services, qualification of human resources; pedagogical scientific quality, credibility as a good institution. However quality in education speaking about what is called of technical competence is essentially the use and dominium of the cognitive means of teaching learning process as well as the available technological means. This level of quality of education has the dependence and straight relation to the teacher and his/her qualification and competence. Good programs have good motivated teachers in addition to modern installations and dynamic planning. The Faculty of any Institution of Education is one of the most important element, which provides or not its qualification of excellence [02].

In order to fulfill a lack of engineering educators for high education for engineering and technological fields in the country COPEC - Council of Researches in Education and Sciences education team has designed a new program in graduation level: the Professional Engineering Education. The goal is to improve the formation of the engineering educator providing them with all the competencies needed to teach at the state of the art with the best available teaching technologies.

The so called PEE Program offers two graduate degrees: the Master of Science and the Doctor of Philosophy and it is a very dynamic and rich program, developed in modules, followed in several countries in the world. It follows the trend

of global formation of professionals, mainly to attend the need of a prepared engineering educator to act in the several different cultural environments, which mobility has imposed as a fact of life for researchers and teachers at graduation level [03].

## II. HISTORICAL ASPECTS OF GLOBALIZATION AND EDUCATION

Along the History it can be seen the human achievements in altering and dominating nature in favor of better ways of surviving. This is how technology was born and prevails improving and now more than ever in much sophisticated levels. Men can now more than ever reach levels of comfort, healing of diseases, increasing age level expectations, moving around the world, watching the news and communicate in real time.

All this thanks to the development of sciences and technology and engineers all over the world are in many ways shaping a new life style, helping to save lives, making transportation faster and more secure, enhancing communications and etc. This isolated aspect – the development of sciences and technology, helped to make the globalization phenomenon a reality once more in human history. In the past Alexander the Great was may be the first leader to promote the globalization through wars and invasions followed by Genghis Khan, Cesar and others. Now the big corporations are promoting the globalization in a more subtle way, may be less painful and traumatic but still invasive. If it is good or bad the future will tell us, there are pros and cons being widely discussed but the fact is that it is there. It is the evolution of the capitalism system predominant in the world and sciences are occupying its place of relevance in world scenario [04].

One positive aspect of present world is that the nation's world wide is recognizing the importance of engineers once they are the ones that make possible the world goes round.

In academic midst the discussions about the formation of engineers are receiving more and more incentive and many real actions have been applied with success. Many new engineering programs have been conceived and are working well, more flexible programs, more investments in labs and equipments, more exchanges programs and so on. It is the education evolution in order to adequate the formation of engineers for the future. So Future is the keyword once the world is changing so fast as well as the labor market.

The Universities and their Schools and Institutes have been sacrificed by the so called globalization that imposes certain needs that are absolutely new and many of them not so necessary. It is no longer a matter of using multimedia equipment in classroom but fundamentally to look for new more appropriate and captivating contents to present to the new plugged students. Besides all of the technical and pedagogic aspects it is necessary to think about the psychological aspects of this great and passionate process of teaching. For the good or for the evil, there it is this new socioeconomic and political world of contrasts in which only the education can really change for better [05].

Speaking about education for best, the professionals who leave the universities today leave already with a stock of knowledge that is partly obsolete and s/he has to run fast to adapt to the new job market. Is this the fault of the University? The answer is no, the University has been serving the society for centuries and without interests others than the investigation and the improvement of the knowledge that generates benefits for the humanity as a whole.

What about the teacher? The new teacher has to preserve the curiosity, to urge the capacity of the students' inquiry; he has to teach them to learn and not to suffocate them with a mountain of scientific and technological knowledge, that today the teacher does in the anguish of teaching better.

## III. SOME CONSIDERATIONS ABOUT GLOBALIZATION

Globalization could be defined as the transformation of the world in a global village, that means “closer contact between different parts of the world, with increasing possibilities of personal exchange, mutual understanding and friendship between "world citizens", and creation of a global civilization.” Nevertheless analyzing Globalization on the economical-financial side it began in the 80's with the integration at world level of the economical and financial relationships. It presents two aspects: the negative and the positive.

As positive aspect is the cultural and commercial exchange among people and nations; in the course of two generations the gap between the industrial and the developing regions narrowed substantially everywhere; the overall poverty, when defined by health of population and life expectancy, as well as by income has diminished [06]. By the other hand the results of globalization have not been what was predicted when the attempt to increase free trade began, and many institutions involved in the system of globalization have not taken the interests of poorer nations, the working class, and the environment into account; developed countries are the largest beneficiaries of this system and they are becoming richer while the developing countries are becoming poorer.

The discussions about Globalization in general show a bad scenario and the future is unpredictable once it is not possible to foreseen the big players' next movement in such huge business game of fighting for markets.

## IV. SCIENCE AND TECHNOLOGY IN GLOBAL WORLD

Scientists for centuries can see the world as a unified heterogenic content and capable to comprehend the whole. In a sense, science is responsible for the idea of globalization. Furthermore, as a system of knowledge, science has been uniquely successful at building widely shared understandings that transcend political and cultural differences.

Information Technology known as IT is a driving factor in the process of globalization. Improvements in the early 1990s in computer hardware, software, and telecommunications have caused widespread improvements in access to information and economic potential. These advances have facilitated efficiency gains in all sectors of the economy. IT provides the communication network that facilitates the expansion of products, ideas, and resources among nations and among

people regardless of geographic location. Creating efficient and effective channels to exchange information, IT has been the catalyst for global integration [07].

## V. THE NEW WORK MARKET

Science and technology innovations have shaped the present work market in such a way that from now on “changing” is the role and not the exception. It is a changing world and a changing work market in every level. Technology has enhanced work place that means less hand work and more mental work. Thanks to information technology the workplace is now team-based. Management styles have changed with horizontal structures where everybody is responsible for the results of the work requiring less supervision. For workers in any level the expected profile comprehend attitudes and behaviors to work in teams. The job environment is different due to the way that companies run the busyness now; jobs positions are displaced, others take places and shifts are always changing in according to the new necessities.

Among the dramatic changes in work market it is noticed that now more jobs are part time; more people are self employed; less staff needed to accomplish works; paid and unpaid overtime work are increasing; global competitiveness; flatter organizational structures; companies downsizing, less job security [08].

Human beings are living now in a changing work environment full of surprises and unpredictable events in a daily basis. The best way to overcome and to survive is to be prepared achieving knowledge and be willing to develop new skills.

## VI. HOW BEST TO EDUCATE THE NEXT GENERATION OF ENGINEERS

The global expansion is here to stay.

Advanced communications technologies continue to alter the way businesses and societies conduct themselves and interact with each other. Today's engineers are expected to work globally-collaborating with team members located in various countries with diverse languages and business cultures to engineer products and services that insure the company's competitiveness in the global economy.

How best to educate the next generation of scientists and engineers, who will enter a workplace that has become truly global environment?

There is not only one answer and the point is that the engineering schools are the ones responsible for the formation of generations of engineers who are among others the main responsible for the development of sciences and technology seeking for the betterment of humanity.

Despite the negative aspects of globalization all the scientific and technological advancements have one main goal: make men's life better. That is why machines were designed to do the hard work so that men can have more time for other more pleasant work; the search for new drugs to defeat diseases, to live better and more and so on. Nevertheless all the achievements bring also new situations that are not always

positive that is why engineers should to be more aware of social responsibility, to be aware not only about the economic and environmental issues but also the impact of new technologies in the society. Any isolated event in the current world in one or another way has some effect in other regions of the planet and sooner or later they will be felt. To deny it is the same as to “sweep the dust under the carpet” [09].

So, summarizing the formation of the engineer for the future must consider besides the strong basis in basic sciences and basic sciences of engineering the development of:

- Communication skills;
- The willing to learn all life;
- Positive attitudes and behaviors;
- To work in teams;
- Responsibility for actions and results;
- Respect to diversity;
- Entrepreneurship;
- Self employability;
- Self management.

May be the main skill is the development of the capacity to see the opportunity of a new work, a niche that can be explored and generate good results no matter where it is. The experience of studying abroad is an efficient way to give the students an opportunity to get in touch with other cultures and to develop communication skills in an upper level. The learning of languages and the sensitiveness to behave properly are some the positive results of this kind of experience. It has to be a structured program with defined goals and flexible schedule [10].

## VII. THE CHARACTERISTICS OF THE NEW PROFESSIONAL

In this new world scenario the skills, knowledge and training that are required are fundamental to survive in the changing labor market. It is imperative to be able to manage technological changes, be creative, take calculated risks, manage stress, think conceptually and recognize and respect people's diversity and individual differences.

The knowledge required includes the general knowledge of the busyness, the understanding of the total organization, at least a general knowledge about computers among others. The academic knowledge must provide the basic foundation to get, keep, and progress on a job to achieve the best results.

It is necessary more than ever to develop multi skills, communication skills in order to work in teams, to be willing to retrain, to study constantly in order to learn new technologies rapidly; it is life-long education [11].

## VIII. THE PROFILE OF 21ST. ENGINEERING EDUCATOR

Specifically speaking about the profile of next generation of engineers committed with education, working in classrooms it is important to discuss some points such as the basic research that is now recognized as an important element in the development of high technology. Universities are in a good position as they have been recognized by the governments and industries as crucial to foster their development.

The formation of good engineers and professionals in technological fields is fundamental for the governments, the industries and societies. The relevance of teaching practice is increasing in order to provide good teaching and guidance for the future professional, researcher or teacher.

The profile of an Engineering Educator is based on three fundamental premises [12]:

- A solid base of disciplines of Sciences of Engineering is the basic demand for the professionals of Engineering and Technology fields dedicated to the Education.
- A good knowledge about Education in Engineering is in the same way important and a course of appropriate training should be equivalent to one semester in university (a minimum of 200 hours) in content terms.
- A minimum of a year of practical work as professionals in one of Engineering and Technology area dedicated to the Education.

#### IX. THE PEE PROGRAM

The PEE program follows the patterns of IGIP - International Society for Engineering Education registration for Engineering and Technology, the qualifications and professional experience at an advanced level. This society provides a title that has been recognized in several countries in Europe and now spreading all over the world.

The formula for the title "ING-PAED IGIP" is:

Qualification in Engineering

+

Training of Education in Engineering and Technology

+

Practice in Engineering and Technology Education Area.

The engineering qualification should correspond preferably to "Europe Ingenieur (EUR-ING)" qualification for FEANI. In Brazil it follows the defined patterns for CFE/CREAs – Federal System of Engineering in the engineers' case and of the organizations responsible for the other professionals of Technology area.

#### X. ADMISSION REQUIREMENTS

The basic candidate requirement for admission is [13]:

- a bachelor's degree in science, engineering, or technology, or in such fields as computer science/engineering, electrical/ control engineering, industrial engineering, environmental engineering, manufacturing engineering, materials science and engineering, mechanical engineering, or management, etc.
- Students with other backgrounds will be considered based on their interest, formal education and experience in teaching.

#### XI. COURSE INFORMATION

The Master Degree in Engineering Education requires 30 credits in ECT's of graduate studies. The 30 credits consist of a minimum of 12 credit hours of coursework, plus 12 credit hours of any combination of coursework, independent study, directed research or thesis that complies with the following constraints: if there is a thesis, it must at least 6 and no more than 12 credits; there can be no more than 9 credits of directed research; and the total number of credits from the Management Department cannot exceed 14 [14].

The minimum of 12 credit hours of coursework must include a minimum of two credits each in at least four of the seven core areas. The coursework should be selected in consultation with an advisor from the EE faculty. All full-time students are required to participate in the non-credit seminar course.

#### XII. THE MODULAR CURRICULUM

The PEE curriculum is a modular one and it is as follows:

<i>Module Description</i>	<i>Credits at least</i>
<b>Core Modules</b>	<b>8</b>
Theoretical and Practical Engineering Pedagogy	6
Laboratory Methodology	2
<b>Theory Modules</b>	<b>4</b>
Psychology and Sociology	3
Ethics (1 credit) or Intercultural competencies (1 credit)	1
<b>Practice Modules</b>	<b>6</b>
Oral Communication Skills, Scientific Writing	3
Working with Projects	1
Media, E-Learning, Computer Aided Technologies	2
<b>Elective Credit Points</b>	<b>2</b>
Electives	2
<b>In Total</b>	<b>20</b>

Each module has the goal to enhance the development of a competency so necessary for the improvement of teaching styles. There is a demand for educators connected with the new students' Profile.

#### XIII. CONCLUSION

It is a reasonably flexible program that is developed in according to the needs for the accomplishment of the main goal to form engineering educators.

The main characteristic of the program has been to lead the attendees to think "out of the box" imprinting the notion of dynamic teaching environment that is necessary in order to form the new professional. It has been designed in order to fit the necessities of professionals and institutions interested in the improvement of career and quality performance.

All the course evaluations have been very positive. The attendees are satisfied with the approach and the content of the courses. It is a great achievement for academic midst once it can provide for engineers and professionals of technological areas the opportunity to update the knowledge about education as a whole.

It is important to point out that it is a very dynamic program once the content of the courses can be developed constantly taking into account the characteristic of the groups. This aspect is relevant because it helps to overcome the obstacles such as communication problems, stress management and so on.

The number of professionals interested in the program is growing and it is expected a larger number of attendees for next group.

Besides the professional receives a diploma that is recognized national and internationally.

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