Impacto de las estancias profesionales en la formación del Ingeniero Químico

Impact of the internships in the formation of the Chemical Engineer

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Resumen

Este trabajo es el resultado de la evaluación de los reportes de las estancias profesionales de los estudiantes del Programa Educativo de Ingeniero Químico, de las generaciones 2001-06 a 2006-2011, para identificar las principales funciones que desempeñan en sus estancias profesionales, las áreas donde se insertan y el sector que los contrata. La información recabada de las estancias profesionales es un indicador del grado de pertinencia del currículo del programa. Se determinó que 82 % de los alumnos se colocaron en industrias y áreas que tienen que ver con su perfil profesional de egreso; destacan las áreas de calidad, ingeniería aplicada y servicios, y la de seguridad, higiene y protección ambiental. Se identificó que los alumnos desempeñan principalmente actividades propias de su formación y se reconocieron áreas de oportunidad como la de mejorar las habilidades de comunicación oral y escrita y el manejo de equipos de laboratorio especializados.

Palabras clave: formación por competencias, estudiantes, profesores, desempeño profesional.

Abstract

This work is the result of the evaluation of the reports from professional stays of students of the educational program in chemical engineering, from 2001-06 to 2006-2011 generations, to identify the major roles played in professional rooms, areas where are inserted and the sector that hires them. The information gathered from professional stays is an indicator of the degree of relevance of the curriculum of the program. It was determined that 82% of students placed in industries and areas that are related to your professional profile; highlights the areas of quality, applied engineering and services, and the safety, hygiene and environmental protection. Students play mainly own their training activities and recognized opportunity areas were identified as the improve oral and written communication skills and the management of specialized laboratory equipment.

Key words: training by competencies, students, professors, professional performance.

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Introduction

The idea of the educational reforms relate directly to the great economic transformations is widespread in recent decades. This raises the challenge of adapting to a changing environment, a new production paradigm, the redefinition of the culture of the company and new professional profiles that are characterized by solving problems and enable flexible and economic responses in a rational system to the educational system. Today, the social projection at the University is conceived, as Dialogic interaction, relevant and permanent whit various human and social groups, creating channels of communication and participation for the development of human potential (Feire, 1984). This view allows institutions of higher education to interrelate the three substantive functions, because the research and teaching are fed directly from social action, reversing on curricula, professorships and research projects such as the sponsored currently by Administrative Department of Science, Technology and Innovation (Colciencias). It is precisely the social

projection which allows universities to make socially useful values and knowledge, through research and educational action of double-way, where transform society and University, stimulate, grow and be feedback to achieve mutual benefits. This belief gives you a reason and sense of knowledge that builds and recreates the University, thus favouring "a science-minded" and maintaining a critical attitude towards social, technical and business problems and an analytical aptitude to solutions raised for your solution. The relationship between education and the economy, although clear, is less direct than it seems. One of the dynamics of the curriculum reform of the 1970s was the changing economic base of society, that pointed to an economy based on Science and technology. New models of industrial production of educational institutions require a curriculum that integrated fields of knowledge, and at the same time, understanding how it develops, produces and transforms the knowledge, as well as the ethical dimensions inherent in this task; in general, what we know as learning to learn. The recent interest in globalization and interdisciplinarity in the curriculum is related to the internationalization of the social, economic, political and cultural life; with the breakdown of boundaries between disciplines, the need for an applied knowledge and the increasing complexity of the problems facing modern societies (Torres, 1994).

The interest in linking the productive and educational systems had its beginnings in the Program for Educational Modernization 1994 demanded to examine the processes of linkage with the sectors producing goods and services; to accommodate advances in scientific and technological knowledge, updating plans, programs and methods of study and redesign and promote a new system that certifies the knowledge acquired in laboratories and workshops, scientific and technological development activities, self-study and productive life (Federal Executive Branch, 1989). To achieve this it was required related to a process of continuous professional training should include the period in the company, adequate compensation and due process of academic challenge; in general, with the professionalization of teaching, as well as the relevance of education to the changing demands of society.

One of the problems to solve educators internationally, particularly when confronted with the need to adapt education to the demands of modern productive sectors, is the impact of engineering education of scientific progress, rapid technological change and the change in the productive paradigm. Two positions dominate the debate: a) the suggestion of a focus of the courses that include new methodologies, use of information and communication technologies,

teamwork, solving problems in an interdisciplinary way, new considerations in the design and building skills oral and written communication, b) fundamental changes relate to the organization of the studies, contents, means and ways of learning, and even the legitimacy of the knowledge produced in another space than the school.

Competitions

Defined several definitions of the word competition as (Beneitone, 2004) in education is presented as a broad conceptual network, which refers to a holistic way of citizens, through new approaches such as meaningful learning in various areas: cognitive (knowledge), psychomotor (know-how, skills), emotional (knowing being, attitudes and values). In this sense, competition can not be reduced to the simple job performance, not a single appropriation of knowledge to know-how, but encompasses a whole range of skills that are developed through processes that lead to the person responsible to be competent to perform multiple actions (social, cognitive, cultural, emotional, labor, productive), through which projects and demonstrates its ability to solve a problem within a specific and changing context (Campos, 2015).

Professional practice

Internships are an essential com¬ponente formation of higher education students, who begin their inser¬ción them in employment for a specified period and stretching out a bridge between theory and prácti¬ca between the formative stage and entering the labor market (A., 2011). Author (Coleman, 1989) defines the practice as a supervised work expe¬riencia short on dura¬ción, offered as part of the curriculum and carried out during the academic sequence. Permi¬ten practices students to develop new skills and learn to act in a di¬ferente organizational culture. The practice is a key factor in the challenge of adapting to the higher demands of the productive sectors education. In it converge the quality of vocational training, the advancement of knowledge, technological change and innovation, new forms of organization and production globalization and the pressures of regulatory agencies. Knowledge of professional practice identifies the essential in the training and learning the differences between school and learning the business, and the results they share.

José Fernando Restrepo, the practice is a field of confrontation with everyday knowledge learned from doing; both make the professional knowledge required for job performance. This aspect can

adjust the ever changing curriculum content to the needs of the productive system in particular and the social system in general (Restrepo, 2001).

Professional engineering practice in this sector is characterized by the dominance of industrial processes, production flexibility, world-class manufacturing, quality systems, generic knowledge and expertise in specific technology areas; involvement in project development, new product introduction, assimilation of new technologies and design. It involves creativity, innovation capacity and command of another language. It requires knowledge and familiarity with the product life cycle and with the vision of "business" and the ability to visualize the relationship between the corporate, industry and the community. He suggests a "functional" engineer working with interdisciplinary teams, aimed at measuring results, working with industrial software applications and innovation as a daily activity. An engineer with management capacity and globalizing mentality that directs people as a leader and facilitator, professional growth-oriented, self-motivated and able to work under pressure.

The engineering practice is complex and varied, weekly and permanence of 10-12 hours a day in the company, which invested in 41% of the time information work, which requires abstraction and synthesis capacity and skills oral and written communication. 29% in working with other people, for which they need interpersonal skills, adaptability, flexibility in new situations and proactive; 16% in administrative functions, to exercise leadership, ability to act in a multicultural environment and global vision of the company. However, the training of engineers still requires a strong scientific background and extensive knowledge of processes, products and technologies (Aguilar, 2013).

So engineers are agents of change, transforming reality and are competitive globally, a curriculum that contains knowledge as mathematics, statistics, an analytical approach to problem solving and skills required in:

- Oral and written communication and leadership
- Teamwork, inter and multidisciplinary experience
- Familiarity with technology, manufacturing and quality systems
- Familiarity with software for industrial applications
- Development of projects, using models, solving real problems and innovative practice
- Experiences of design as a creative synthesis of the basic sciences and engineering

- A variety of courses in the administrative area that reflects economic reality production
- Practice industry
- Knowledge of a second language, preferably English

In general, the teaching-learning process requires the use of active methods, interdisciplinary problem identification and development of projects; ICT use, exposure to new situations and subjecting students to the same stress and demands of the industry, which is summarized teach them to work under pressure.

In a changing environment, the relevance is challenging. Relevance and quality are interrelated concepts: quality ratio makes the set of qualities that constitute the way of being, superiority, value; It is the search for a dynamic equilibrium between the needs of society and the university, its objectives, missions and functions. The quality of an educational program is established to the extent that is effective, efficient, relevant and transcendent (Gago, 1995). Efficacy refers to the achievement of objectives and results related to; efficiency refers to inputs, optimizing resources, means and opportunity. Transcendence means the potential of an academic program to go further in time, when it serves today and serves morning.

Changes in engineering education realize a rapid scientific advancement and rapid technological change, globalization and a new way of producing. In this context, the curriculum is subject to profound changes relating to the new role of engineers in industrial competitiveness, with the growing importance of knowledge in production and a new professional training required to emphasize the fundamental knowledge of the profession -competencias techniques and sociotécnicas- and the recognition that knowledge production in the company can be of the same quality as those produced in school.

Engineering education requires both new approaches fundamental changes. It is related not only with the new profile of the teacher, in analogy with the production system must be defined in recruiting, developed through a variety of strategies, train for a culture where the most important value is the knowledge, be flexible, have mastery of another language and familiarity with information and communication technologies, be competitive and geared to achieving productivity, with a culture in which emphasis on quality and customer service is made.

Professional stay at the Chemical Engineering Curriculum, UAEM

Since 1997, the Education Program (PE) Chemical Engineering was modified to accommodate new features and challenges of higher education, then the new models for curriculum design that determined that education should focus on the student were adopted. This situation caused that in the curriculum two programs that strengthen the capacities and skills of students as managers of their education is primarily established: the tutoring program and professional stays.

In 2002, the UAEM begins with a curriculum reform process with the Institutional Curricular Innovation Program (IES), in which an educational model focused on skills development is established. In 2003 the Faculty of Chemistry adopted the educational model for competence, so that the curriculum of educational programs offered in this academic body had to be modified to consider in their curricula not only information and learning knowledge but skills development and strengthening of values to be allowed to graduate quickly and more efficiently adapt to the conditions of professional environment, especially in their ability to solve complex problems of their own discipline. In this context, the program was consolidated business trips, seeking to strengthen their professional skills through the following considerations:

- Bring the student's own work environments of their training.
- That the students acquire professional experience.
- Insert the student in the labor market.

Purposes and conditions stays Professionals (EP) established in 2003 the PE curriculum of Chemical Engineering, Faculty of Chemical:

> For the 2003 plan are considered two professional ranches located in the eighth and ninth semester (ideal trajectory). The work placements are considered academic curricular activity that incorporates the student during their training in any area of application of its degree in the professional field. The student will be guided and counseled by a professional, project, department or area where you conduct your stay. The stay professional purposes are, among others: Integrating acquired knowledge, have work experience, engage in problem solving, learn new technologies, identify areas of professional activity, teamwork and improve their personal relationships (Facultad de Química, 2003).

Based on the information gathered from the EP since 1998, one can say that it is clear that the purposes of the business trips are difficult to quantify due to its complexity by the large number of environments in which they operate and labor factors affect, so setting standardized criteria and indicators for evaluation is extremely difficult, and any attempt to evaluate in this regard could be unfair to some students. However, the curricular program committee established an evaluation process in two stages: analysis of final reports and an oral presentation of the results of their stay by a cartel.

Importantly, the EP not only enable students to face the labor market, but also to face the Parliament in this market, ie, the EP is one of the indicators of program administrators (address, academic sub, coordination EP and curriculum committee) to assess the relevance of the curriculum, the content of the learning units, developed skills and attitudes displayed. In this regard, since 2001 it was decided that annually the EP reports and assessments of external advisors be analyzed. It is considered that the analysis of this evaluation is limited in several respects:

- The fact that for students is the first approach to the workplace, employers often put the majority (over 85%) in low-level responsibility.
- The fact that some SOEs are part-time, which favors that in some cases the level of problem analysis is not very deep.
- The fact that some employers place students in positions not at all commensurate with their training.

However, these assessments are considered in the conclusions. In addition, for the analysis of relevance of the program they have established surveys graduates and employers. The most important results of three studies of external relevance of the program have been changes in the contents of some UA in 2006, including another area of stress and other disciplinary electives UA in 2008 and 2013 to integrate part of the foundation of the curricular change the curriculum.

Following the goal set with the assessment of the EP, the methodology followed and the results obtained are detailed.

Objective

Identify the major roles played by students in the EP, the areas where they are inserted and the sector that hires, through the evaluation of the final reports of the students who participated in the EP in the industrial zone of Toluca and area conurbation.

Methodology

The guiding paradigm, from the epistemological point of view, this study is the Empirical Analytical (Hernandez, 2010). This is interested in demonstrating facts from a quantitative methodology.

In 2004, the Broadcasting Coordination, Outreach and Liaison with the heads of department, integrated a format for presenting the report of the professional stays. This document was composed of the following sections: student data; general data of the receiving company; Work plan; activities performed; and applied knowledge acquired; applied and developed skills; Values shown. Further evaluation of student performance, made by his boss included. As one of the indicators of program relevance final reports of the students who participated in EP cycles 2001 to 2011, according to the following scheme were analyzed:

First reports were classified according to the type of companies based in the industrial zones established in the Metropolitan Area of Toluca, where students generally performed their stays. Following this classification list:

- Basic and extractive chemistry;
- Farmoquímica;
- Services and Education;
- Textiles;
- Manufacturing;
- Food and drinks;
- extracts and dyes;
- Basic Chemicals;
- Automotive;
- secondary chemical or consumption;
- Research Center.

As shown in Figure 1, 82% of students were placed in industries that are related to their professional profile of graduates, highlighting the chemical industry, the food, pharmaceutical and pharmochemical.

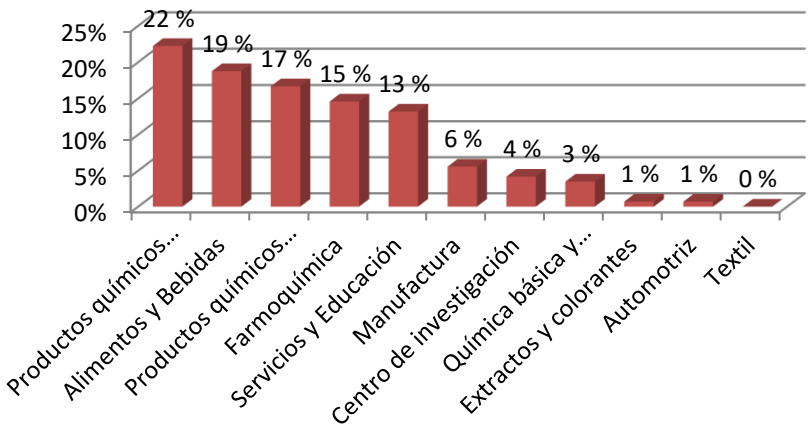

Figure 1. Industrial sector in which students to develop professional stays are inserted. Source: Education Degree in Chemical Engineering program. Professional stays Report (Generations 2001-06 to 2006-11).

Second, the work areas where these areas correspond to the departments to which students have access in their work placements were classified. The following work areas were established:

- Production;
- Quality;
- Maintenance and projects;
- Sales;
- Applied Engineering and services;
- Research and Technological Development;
- Safety, health and environment;
- Training and education.

It can be seen in Figure 2 that the main activities carried out in their professional visits are contained in the area of quality followed by applied engineering and services, and thirdly the area of health, safety and environmental protection; Also, how it will be seen later, aspects of work related to their professional profile.

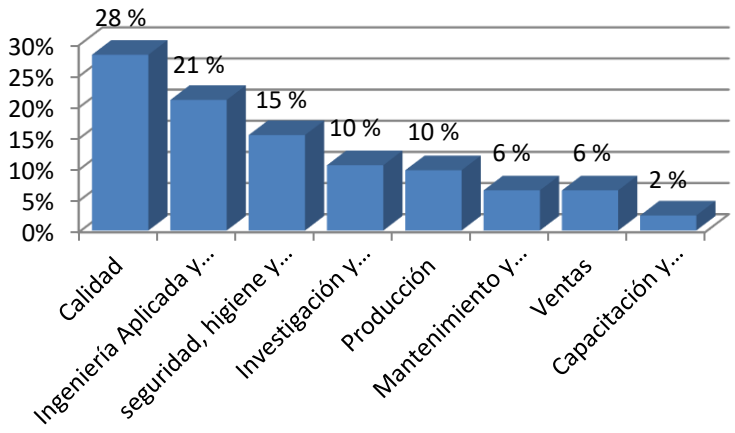

Figure 2. areas or departments where students are inserted to the development of professional stays. Source: Education Degree in Chemical Engineering program. Professional stays Report (Generations 2001-06 to 2006-11).

Third, work activities were classified. The classification of the main activities undertaken by students in each of the work areas are integrated based on information reported by them and thus carried out a categorization of the common activities in the industry; the activities identified are:

- Management of laboratory equipment for analysis;
- Integration of information and drafting procedures;
- Personnel Management;
- Management team or pilot plant processes;
- Management of specialized software;
- Analysis of information processes, measurements, calculations;
- Support activities department, management or supervision;
- Technical Service to other areas.

It is identified that the main activity in professional stays is directed to assist departments or areas in the drafting of documents (reports, papers, presentations, etc.) and integration of information (technical documentation, operating manuals or instrumentation bases data, evidence for certification, etc.).

It also stresses that students are placed in the areas of quality and research and technological development for physicochemical testing and characterization of materials or determining the quality specifications of products and raw materials, mainly. This involves handling equipment and instruments commonly used in laboratory and in some cases specialized instruments and

laboratory equipment. It is also important to note that students develop in areas of health, safety and environmental protection require knowledge of regulations and environmental regulations.

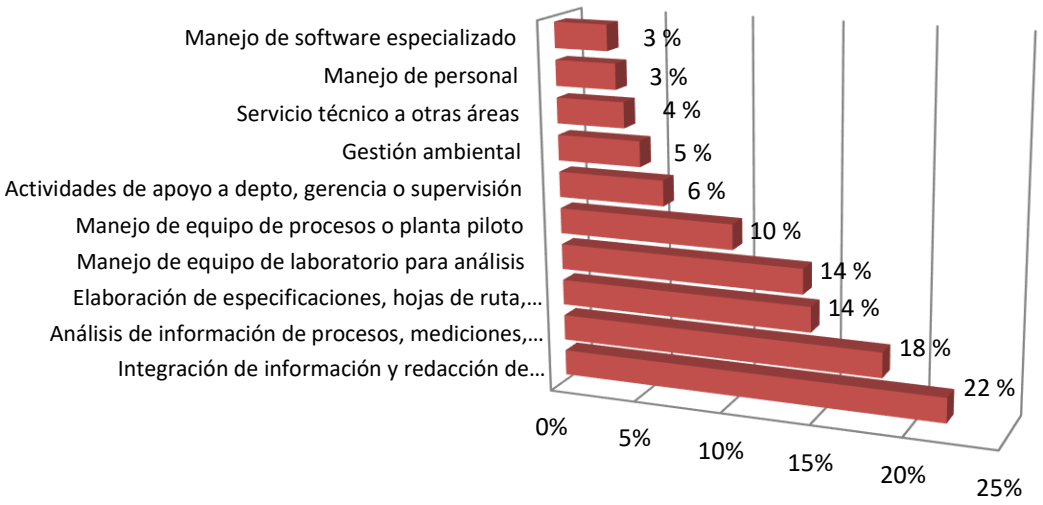

Figure 3. Main activities undertaken by students in work placements. Source: Education Degree in Chemical Engineering program. Professional stays Report (Generations 2001-06 to 2006-11).

Fourth, the skills used and / or developed were classified, as reported by students and assessments of the chiefs, being: oral and written communication; management of computer and basic software; specialized management software; management of laboratory equipment; personnel management; ability to learn by itself; oral and written communication in another language; ability to make decisions; teamwork. This category highlights the need to improve the skills of oral and written communication and management of specialized laboratory equipment.

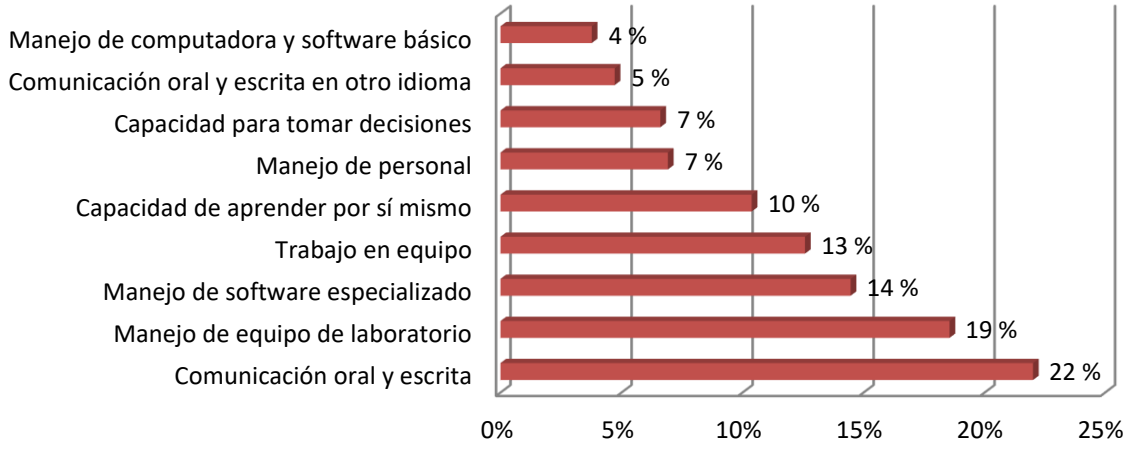

Figure 4. Key skills required by students in the development of professional stays. Source: Education Degree in Chemical Engineering program. Professional stays Report (Generations 2001-06 to 2006-11).

In terms of specific knowledge, the students and their leaders mentioned learning units or subjects that required knowledge for the development of activities in their tents. In this area the results are widely dispersed, however, in Table I listed the most relevant.

Table I Main specific knowledge applied in the development of professional stays

Conocimientos específicos	**Porcentaje**	**Conocimientos específicos**	**Porcentaje**
Técnicas de calidad y manufactura	11 %	**Química orgánica**	6 %
Calidad	10 %	**Administración de proyectos**	6 %
Procesos unitarios	10 %	**Química analítica**	6 %
Normas de seguridad	9 %	**Tecnología ambiental**	6 %
Administración y contabilidad	8 %	**Validación de procesos**	5 %
Termodinámica	7 %	**Balance de materia**	4 %
Flujo de fluidos	3 %	**Reactores y equipos de procesos**	3 %
Diseño de equipo	2 %	**Normalización y metrología**	3 %
Mecánica eléctrica	2 %	**Química inorgánica**	1 %

Source: Education Degree and Chemical Engineering Program. Professional stays Report (Generations 2001-06 to 2006-11).

Finally, the section reviews 82% of employers expressed a favorable opinion about the performance of students and the training received by the EP. Furthermore, tracking students has been determined that 5 to 30% per generation are hired from the EP.

Conclusions

From the analysis made of EP reports of students in Chemical Engineering Education Program, we may conclude the following:

1. Chemical Engineering PE 2003 has an appropriate level of external relevance, according to the opinion of employers.
2. In general, students perform functions according to their graduate profile, and most are located in the industrial sector (chemical companies, pharmaceutical, farmoquímicas,

food, mining and manufacturing), and to a lesser percentage service sectors (education, public and consultancies).

3. Considering the evaluation of employers, the program structure is appropriate, the development of skills in the use of specialized equipment and laboratory instruments being necessary.
4. The ability to use ICT and specialized software is a strength in students.
5. The other approach work placements to students within their areas of performance.
6. The EP is a means to enter the labor market.

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