

CHEMICAL ENGINEERING AND COMPETENCES IN ECOLOGY

Antonio Valiente Barderas¹, Carlos Galdeano Bienzobas²

^{1,2}Fac. de Quimica, UNAM, CU. México City, Mexico
faty_avb@yahoo.com

Abstract

Environmental degradation, global warming and sustainable development are topics to be included in the curriculum of the chemical engineer to reach cognitive skills and attitude competences to deal with these burning issues of today. While the current curricula have some materials dealing with the issue of ecology and pollution, the authors have found, by means of a survey, that students are not sufficiently informed or trained to understand the complexity of pollution, global warming and sustainable development. Therefore we recommend to support the formation of these competences through the cross and hidden curricula.

Keywords: Competences, Global Warming, Pollution, Ecology, Sustainable Development.

I. INTRODUCTION

In the context of globalization that we live in, we have witnessed the rapid changes that are generated in each of the spheres of the society. The various technological advances, instant communication, the evolution and revolution in different fields of knowledge and the emergence of new ideologies are some of the triggers that have altered the interpersonal relationships, the everyday life and the educational models.

The society of today requires flexible strong educational systems, in permanent innovation, which respond to the social development in constant transition and renewal. It is no coincidence then, that in the late 1960s, there emerged simultaneously in some countries of the First World an alternative educational movement aimed at bringing together theory and practice in the training of workers and in the training of professionals.

Much of the academic literature claims that the new model, which is usually called 'education competency', originated simultaneously in Australia, New Zealand, United States, England and Canada. These were educational model that aims to narrow the gap between the school of social needs and the world of work.

What characterized this new educational model was that it helped build bridges of communication between school, work and social requirements. In addition, it provided a permanent dialogue between educators, industry production and services.

Competency-based education displaces the teaching of traditional content, as they do not have a practical use and expire quickly in this abundant knowledge generation. The new education changes the attention towards the formation of theoretical and practical contents that leverage cognitive structuring of strategies and procedures for action and intervention; thus teaching works in the formation of attitudes, values, abilities, skills and capabilities in specific

thematic fields and relevant to the changing needs of job performance.

In short, competency-based education requires the institution to form efficient and successful labor performances that allow the student or future worker to exercise with ethical, efficient and successful way its work. Coll [1]

The competencies in the jobs include the professionals, those that enable flexible, creative and competitive performance in a specific professional field, and promote the continuous improvement of being, knowing and doing. These "must enhance and enable performance competitive, flexible and creative, and should prepare the individual for the profession, society, family and also for the work, but not exclusively for this. The professional of today has a high probability of being forced to assume different occupations throughout his life. These must be demonstrated by competitive performance; you need to be aware of their knowledge and the way to put them into practice in complex and changing occupations and tasks. The challenge is to move from an 'unconscious competence', i.e. know-how without knowing how, to a 'conscious competition', that is, the knowledge do and know how. In addition, as a professional, the person should know what is well done and be able to propose new ways of doing it.

1.1. Skills on Sustainable Development and Ecology

Historically, the way of thinking that resulted in the industrial revolution of the 19th century introduced criteria determined by economic growth. These criteria can be found in the calculation of the Gross National Product, dating back to the 1930's. Some corrections were made in the second half of the 19th century in the social sphere, with the emergence of non-profit organizations and trade unionism. The term "economic and social" is part of the vocabulary. But the developed countries (or countries of the North) realized in the years 1970 that its prosperity is based on the intensive use of finite natural resources, and therefore, in

addition to the economic and social issues, a third aspect was neglected: the environment. For example, the ecological footprint worldwide exceeded the Earth's "biological" capacity to recover in the mid-1970s. The term sustainable development applies to socio-economic development and it was formalized for the first time in the document known as the Brundtland report (1987), fruit of the work of the World Commission on environment and development of the United Nations, created in the Assembly of the United Nations in 1983. This definition would assume in third principle of the Rio Declaration (1992)

Meet the needs of present generations without compromising the ability of the future to meet their own needs.

The field of **sustainable development** can be divided conceptually into three parts: environmental, economic and social. It is considered the social aspect by the relationship between social welfare to the environment and the economic bonanza. The triple result is a set of performance indicators of an organization in three areas.

They must meet the needs of society such as food, clothing, housing and work, but if poverty is common, the world will be heading to disasters of various types, including the ecological. In addition, development and social welfare, are limited by the technological level, the resources of the environment and the capacity of the environment to absorb the effects of human activity.(Rojas,[4])

This situation raises the possibility of improving the technology and social organization in such a way that the environment can recover at the same rate that is affected by human activity. To some analysts, the current industrial development model is not sustainable in environmental terms. The critical points are: the depletion of natural resources (such as raw materials and fossil fuels), the destruction and fragmentation of ecosystems and the loss of biodiversity, which reduces the capacity of resistance of the planet. The industrial, agricultural and urban development generates immediate and postponed contamination (for example, acid rain and the greenhouse gases that contribute to climate change and to the excessive exploitation of natural resources, or the deforestation of the rain forest). This causes an inestimable loss of biological diversity in terms of extinction (and therefore irreversible) species of plants or animals. This evolution leads to a depletion of fossil fuels and raw materials making imminent peak oil and bring us closer to the depletion of many vital natural resources. A problem of equity is added to the problem of viability: the poor are those who suffer most from the ecological and climate crises, and is afraid that the legitimate desire of growth in countries developing towards a state of similar prosperity, based on equivalent principles, involve an even more important and accelerated biosphere degradation. If all the Nations of the world were to adopt the American way of life (which consumes nearly a quarter of the Earth's resources for 7% of the population) one needed from five to six planets like Earth to supply them. And if all

the inhabitants of the planet lived with the same standard of living than the average in France, at least three planets would be needed as the Earth.(Savater,[5]).

In addition, the industrial disasters of the last thirty years (of Chernobyl, Seveso, Bhopal, Exxon Valdez, etc.) have called attention to public opinion and to associations such as WWF, Greenpeace or Friends of the Earth. It is noted that sustainable development is not by itself a sociological element, but should be part of a tissue in which the production, economy, welfare and the environment play always on the same side. This concept of sustainable development, focuses from the environmental supply side. I.e. a basic productivity, according to the capacity that can be supplied by the ecosystems. The evolution of thinking on development, in historical terms, has been given within the framework of social struggles: through the struggle between capitalism and socialism, between the working class and the capital, and between the human thought and the forces of nature. Over the last seven decades of the 20th century, and part of this first decade of the 21st century, the concept of development has been expanded and enriched, but it also has been fragmented, since that it is taking the aspects according to the severity that confront countries in their environmental diagnosis, without assuming an universal orientation of care for the environment. The planet Earth is facing the challenge of reversing the impacts caused by man. The environmental crisis is complex and has to do with the ways in which society has been linked to the environment. This relationship involves historical and social aspects. Any human activity has to do with nature in its different areas and spaces, regardless of the level that you want to observe. Environmental problems have to do with the lack of environmental awareness, shown by the attitude that we express to our environment. We need to learn new ways of seeing reality, assuming the new paradigms with a world view of the context in which we live. Sustainable development has emerged as an alternative. It is defined as the model of development that meets the needs of current generations without compromising the ability of future generations to meet their own. It is a proposal that seeks to balance economic growth, environmental protection and social equity. One of the aspects that has been given importance is the eco-friendly. The global environmental situation demands us to remedy the discomforts of the Earth. Constitutes a central aspect of the ecological question the relationship of love and intelligence of the man with the world, which leads to recognize that nature is not an absolute reality, that is, nature is not God. If we divinized the nature, if it is considered a Supreme and absolute value, we invent a kind of false religion in which the man is subordinate to the "Mother Earth", in a destructive naturalism for the man and the same environment. The relationship of love and intelligence of the man with the ecology leads to the recognition that nature is not a mere instrument that man can use at will, misuse or destroy it. Based on before this, man comes to recognize that the environment constitutes a richness and a good man to have; but it is for all mankind present and future; and that it must be kept so that current and future generations to live with

dignity. It is to promote sustainable development, consider the man conservative environment, and responsible place science and technology at the service of life and human dignity; and eliminate poverty, which is one of the worst enemies of the environment as a consequence of the degradation that it produces.

Ultimately, the ecology is an anthropological question. Ecology is a human science, i.e., a knowledge that only comes from man ; and since the human nature, the ecosystems and the environment can only be considered and treated in their intrinsic value. Also part of the ecology the field of wildlife of man, because the human body and corporeal life of human beings connect it with nature in an intimacy such that the same man is a natural being. The development of science and technology have allowed man to learn that man can influence, modify and even destroy the rhythms and laws of nature; but there are limits to that power. Use the strength of the technique in the bosom of nature as expression of a pure will power means not to take into consideration the value of living beings, of the natural life of man, ecosystems, etc. Not considering the value of things, which is the result of a judgement of the consciousness of the man from the discovery of the truth and of being, puts in a way in which everything is subject to the arbitrariness of power, with the risk of this becomes a destroyer of nature, man and other living beings of the Earth. Moderation and the criteria of intervention of man in the ecosystem, the human person, in plants and animals, are the truth and the value of these. These beings, only the man is person and, therefore, the only one that has an absolute value, source of inalienable rights, including the right to life, from conception to natural death; the right to freedom; the right to the family as human home for every man in the world; the right to education and culture. These rights are for the man the source of human and ecosystem ecology, because they contribute to raising awareness and ecological commitment, both in relation to nature, in each and every one of the men as regards natural life, your life and the people, which has special relevance for scarce natural resources. It is possible through sustainable development to avoid the distress of waking up every day in a world governed by the excessive ambition and selfishness; a world that is heading for destruction in various fields; destruction of our habitat, of the values essential to the survival and viability of any society... Destruction, in short, of the heritage that is for us to build and protect for those who will come after us. Humanity must face its responsibility before the current state of need faced by millions of people, as well as the imminent danger that looms over the viability of human life on Earth the current over-exploitation of resources. It is urgent, necessary and urgent to give an immediate step towards the revision and amendment of the development models.

1.2. Ecology, Pollution and Sustainable Development A Necessary Competence for Engineers

The model of professional skills sets three levels: basic skills, the generic and the specific or techniques, whose generality range from the large to the particular. (Valiente, 2010 [8]). Among the basic skills that should have been reached at the end of the compulsory education stage so that the person is prepared for their adult lives, but which also should continue perfecting through new experiences., is the competence in the *knowledge and interaction with the physical world*. A competition that allows you to interact with the environment and to predict consequences. To show care and respect for the environment and to procure its enhancement and preservation as a way to improve the conditions of life of its own and of others and the rest of living beings. Generic or transversal competencies have been defined as the attributes that should have a university graduate regardless of their profession. They can pick up generic aspects of knowledge, abilities and skills and abilities that should have any entitled before joining the work market. They are the common basis of the profession or refer to the specific situations of professional practice that require complex answers. Generic competences are those that not only have a technical component, but also one essentially human. They are the skills and resources that we all have, by the simple fact of being human, and therefore put into play in areas where we operate. Systemic (transverse) generic skills that every professional should possess include sensitivity to environmental issues and the ability to apply theoretical knowledge to practice (Valiente, 2010 [8]). Finally, specific competences are the particular basis of professional practice and are linked to specific conditions of execution. Specific competencies have been defined as the attributes that need to acquire the future graduates during their stay at the University and they must be defined by the experience of graduates. When speaking of specific professional skills we talk about the typical functions or role of a professional in the society and the typical situations of the professional field. There is no doubt that chemical engineering professionals should possess skills in the resolution of pollution problems, environmental and their own criteria to evaluate which is the technique that promotes the sustainable development and which not. The ecology problems are not only solvable from the point of view of science and technology, but it must be addressed as ethical and economic problems. The ethic part of considering, above all, the quality of man's relationship with the other men, recognizing them beings that have the same dignity and the same value as the base. Once recognized the personal dignity of other men, we can enter to consider the relationship of humans with the environment. In this regard, we should bear in mind that only the man knows and can recognize the value and the sense of ecosystem, environment, organisms - plants and animals - and also itself. Ecology arises when man becomes aware of his relationship with the natural ecosystem of the Earth.

Scientific and technical knowledge as well as the ethical assessment of what is sustainable development and care for the environment are competencies that should be part of the knowledge, skills and attitudes of chemical engineers. The mission of the universities is to educate future professionals

in chemistry capable of analyzing, identifying and assessing the limitations of development and undertake work and original and multidisciplinary research that contributes to the solution of the problems posed by industrialization and the conservation of natural resources.

Until recently the chemical industry and its scientists, engineers and technicians were considered as the biggest destroyers of the environment, but that perception is changing because of the emphasis that some pioneering institutions are doing about sustainable development and the green chemistry. Moreover in the majority of the schools and colleges where chemical engineering is taught within the official curriculum there are subjects such as ecology, sanitary engineering, environmental engineering, etc. But that, we believe is not enough, we must raise awareness among both students and teachers on the importance and relevance that has the knowledge, skills and good attitudes about the treatment of industrial waste, energy-saving and green chemical call for the future of our species. For a world hungry of energy, the science and the technic offer today more possibilities than the use of oil, gas and coal. Today many countries obtain energy from the sun, of the tides, wind, biomass (fermentation) and rivers (dams). The atmosphere is essential for life so its alterations have a great impact in humans and other living beings and, in general, across the globe. It is an extraordinarily complex environment and the situation becomes still more complicated and difficult to study when you add in many man-made emissions, as it is happening in these last decades. Contaminated atmosphere can damage people's health and affect the lives of plants and animals. But, in addition, the changes that occur in the chemical composition of the atmosphere can change the climate producing acid rain or ozone destroying, all phenomena of a great global importance. It is understood the urgency of knowing these processes and take the necessary measures so that there are no serious situations of humanity and of all life the biosphere. Since time immemorial, rivers, lakes and seas collected wastes produced by human activity. The natural cycle of water has a great capacity of purification. But this same ease of regeneration of the water, and its apparent wealth, makes it the usual dump where we throw the waste produced by our activities. Pesticides, chemical waste, heavy metals, radioactive waste, etc., are in amounts higher or lower, when analyzing the waters of the most remote places in the world. Many waters are contaminated to the point of making them dangerous to human health, and harmful to life. The degradation of the water comes from old, but has been in this century when this problem has spread to rivers and seas around the world. First it was rivers, port areas of big cities and industrial zones which became dirty drains, loaded with chemicals, foam and all kinds of contaminants. With industrialization and economic development this problem is has been moving to countries developing, while major improvements occurred in developed countries. Soil contamination is the presence of chemical compounds made by man or other alteration to the natural soil environment. This contamination usually appears when on the ground we have either voluntary or

accidental various products such as paper, glass, plastic, organic materials, solvents, pesticides, hazardous wastes or radioactive substances among others. Contamination also occurs to produce a rupture of underground tanks, with the application of pesticides, leaks from landfills or direct accumulation of industrial products. The most common chemicals include derivatives of petroleum, solvents, pesticides and other heavy metals. This phenomenon is closely related to the degree of industrialization and intensity of use of chemicals. With regard to soil contamination risk is primarily health, directly and to come into contact with drinking water sources. The delimitation of the contaminated areas and the resulting cleaning of this are tasks that consume time and money.

To the IPCC (Intergovernmental Panel on climate change), the term 'climate change' denotes The warming of the climate system is unequivocal, as it can be seen already from the observed increase in global average temperature of the air and ocean, the widespread snow and ice melting, and the increase in the global average of the sea level. A change in the State of the climate (for example, by statistical analysis) as a result of a change identifiable in its properties, and that persists for an extended period, usually encrypted in decades or longer periods. It denotes any change in climate over time, so if it is due to the natural variability as if it is the result of human activity. Most of the observed increase in global average temperature since the mid-20th century is most likely due to the observed increase in the concentrations of GHG (greenhouse gas) anthropogenic.

2. CHEMICAL ENGINEERING AND THE TEACHING OF ECONOMIC VALUES.

Many aspects have changed in recent years with the development of new technologies because the access to information is much faster, and this last factor has caused radical changes in the subjects and in the process of teaching and learning (Gordillo and Osorio, 2003 [3]).

The UNESCO (1998 [7]) stated that it is necessary to promote a lifelong learning and the construction of adequate skills to contribute to the economic, social and cultural development of the society. It also noted that the main tasks of higher education have been and will continue to be linked to four of its main functions:

- Generation of new knowledge (research functions).
- The training of highly qualified people (education function).
- Provide services to society (social function).
- Social criticism (involving ethical function).

We can define education as an educational system that emphasizes the learning and demonstration of those competencies (knowledge, skills, attitudes and values) that are of central importance for the execution of a task, activity. (Valiente, 2010 [8]).

Skills-based learning offers the training of professionals, whereas basically training required to transform to a basic professional preparation, provided by successive majors,

higher adaptive capacity and versatility, allowing a professional mobility and subsequent professional retraining, for which should be amended education at all levels.(Coll,[1]).

The knowledge, skills and values related to a discipline are important aspects in which the graduate has to work.(Scheler, [7]) However, in general, a new professional is not prepared or, at least, is not aware of the values and generic skills that has developed and doesn't know how to apply them in the daily performance of their jobs.

It is therefore very important that top-level institutions based their education in competitions, since in this way prepares the student to be able, in an effective and efficient way to apply the knowledge acquired at the University.

The importance of skills-based education, is based on the fact that knowledge that students learn today will be obsolete tomorrow. Generic skills, on the other hand, do not age, they develop and increase, especially if learned in an institutional climate that it promotes learning.

The careers related to the field of the chemical sciences study the composition, structure and properties of matter, as well as the changes that occur therein, the also study the relationship of the changes with power and the laws that govern those changes or transformations. *They* have as a mission, not only the research of new substances and their properties, but also how to create those new substances and the study of the positive or negative effects that could result on human beings, other living beings and especially the environment. The foregoing has economic undertones. Both research, production, education and the fight against pollution have a cost, which will have an impact on the decisions and actions taken.

In some chemistry careers, notably in chemical engineering, there is more emphasis on the economic aspect of the practice of the profession and is therefore included some subjects in the curriculum such as: *economics, economic engineering, engineering costs, etc.* (Faculty of chemistry, 2011 [2]). However, it is distressing to note that the majority of the students have no idea of the costs that have the materials, or the energy, and they do not realize how costly is the research and even the teaching of these topics.

3. SURVEY APPLIED TO SEVERAL CAREERS AT THE FACULTY OF CHEMISTRY.

Obviously, the students do not have an idea of the impact of chemistry in the economy, the dependent which is the society of energy, materials and services that are obtained from chemical, petrochemical, food, metallurgical, pharmaceutical, cosmetics, etc. The do not realize the costs that have pollution and the fight against. This is shown in the results of a series of questions that were made to the students of the Faculty of chemistry of the UNAM in Mexico City. Of the survey that was made with 126 students we can point out the following:

Profile of Respondents

A total of 126 respondents classified in three careers: chemical engineering (74), food chemistry (24) and chemical pharmacist biologist (28). See Fig. 1.

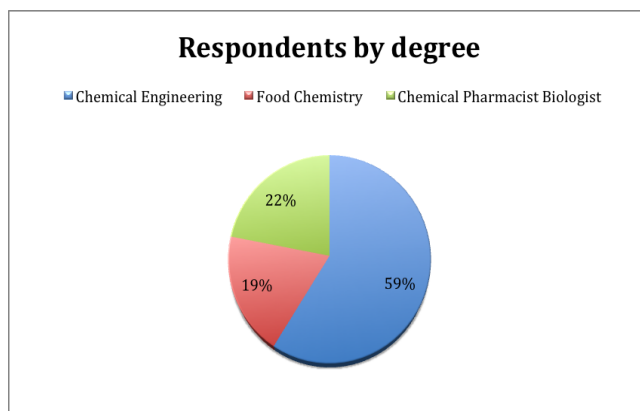
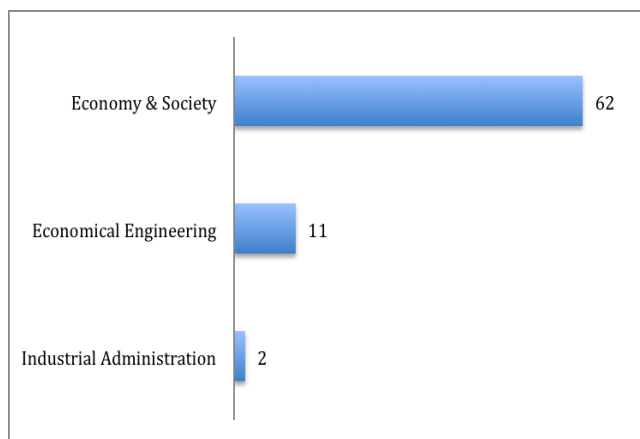
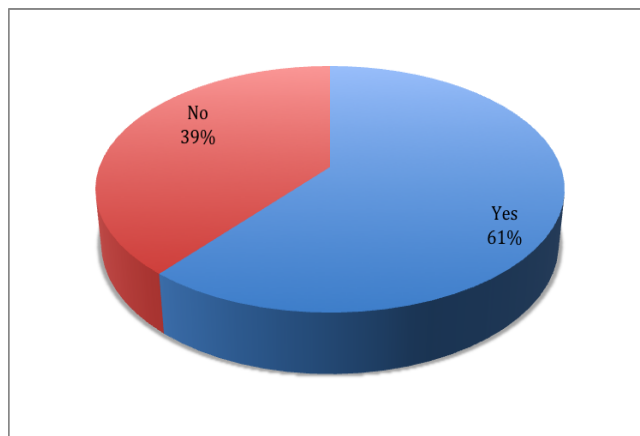


Figure No. 1. Surveyed students and careers.

Although most of the respondents (125) believe that it is important to know the cost of energy, and 75 of them said that they have taken some subjects on economy and economic engineering, (Fig. 2). Most of them indicated that the information they possess on energy and the cost of this is not adequate (124 replies). Fig. 3 and 4.



Figures No. 2 and 3. Have you taken some subjects related to economy and costs?

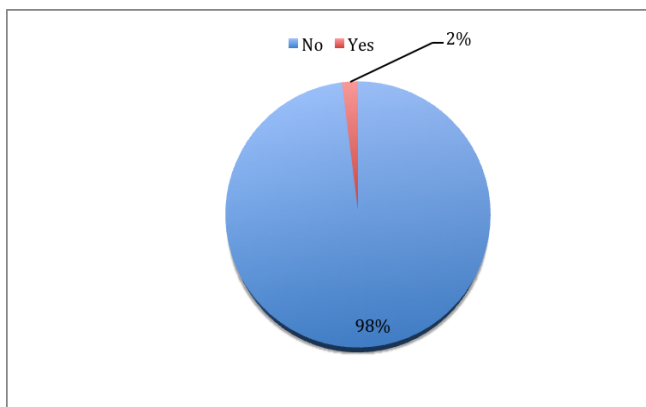


Figure No. 4. Do you consider appropriate and sufficient the information that you have taken on the topic of energy and its cost?

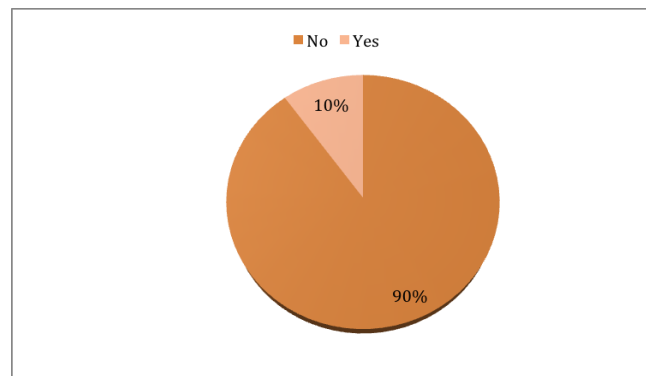


Figure No. 7. Do you know how much it is the cost to produce a new drug?

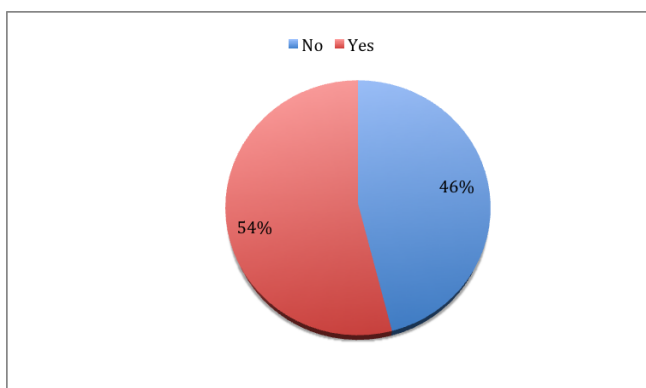


Figure No. 5. Do you think that the curriculum give you the opportunity to have information on energy and costs?

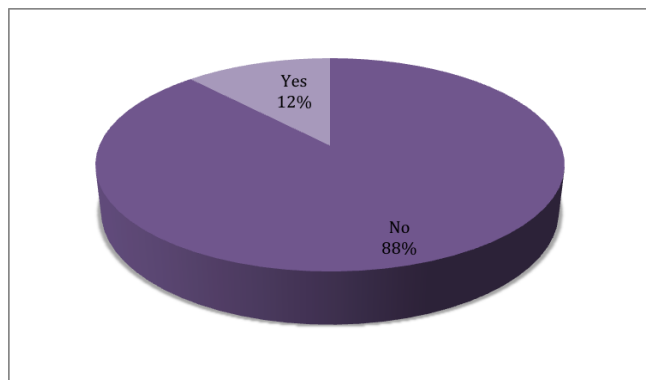


Figure No. 8. Has anybody informed you the cost of a new refinery in Mexico?

The above is shown in the answers given for the students to most of the questions about fuel costs, pharmaceutical products and refining costs.

These results that can only be the reflection of the academic situation of the Faculty and indicate that the orientation of teaching is wrong and that it has neglected the formation of the future professionals in the chemical aspect of costs, the economy and energy, making them low-skilled to meet the industrial world of the 21st century, and certainly without basic skills to face the challenges of lack of energy, the rise of raw materials, the costs of pollution and global warming.

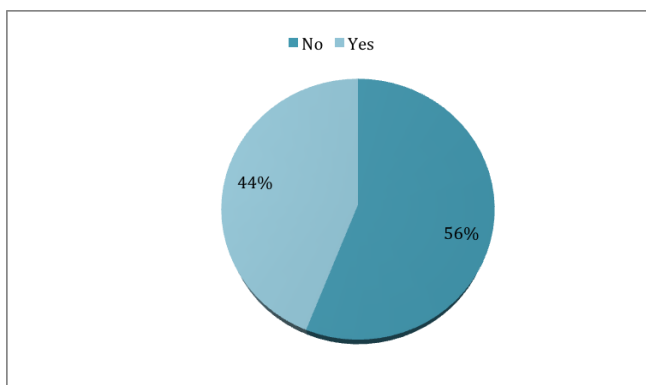


Figure No. 6. Do you know the cost of gasoline in Mexico?

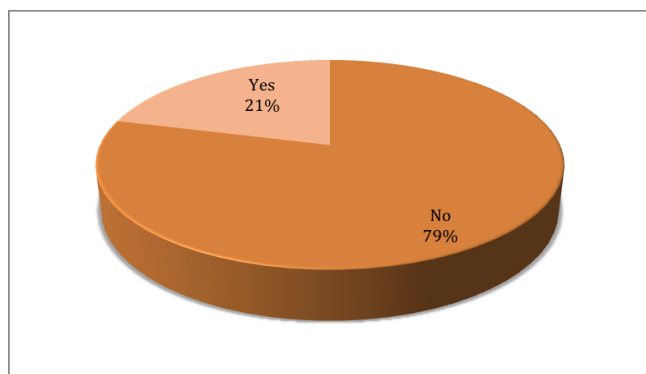


Figure No. 9. Do you know the monthly cost for students of careers in chemistry?

The costs mentioned ranged between \$5.00 and \$12.00.

The situation of the country (Mexico) in science and creativity leaves much to be desired, just 197 patents for research projects were recorded in Mexico in 2008. UNAM requested 17, followed by the Autonomous University of Nuevo León with 12, UAM with 10 and the State University of Guanajuato with 9. On the private side, the Institute of

The History of the month of November 2015 showed the following costs:

Magna	Premium	Diesel
13.72	14.57	\$12.81

Technology and superior studies of Monterrey submitted 31 requests. There is currently no state policy that establishes what wants to be Mexico in 20 years. India and South Korea have been good examples in electronics and information technology, as well as in chemistry.

4. CONCLUSIONS

We believe that a solid background in skills related to ecology and pollution, and sustainable development is essential to the chemical engineer of the 21st century. Certainly they can be included in the curriculum materials that support these topics, but we believe that the most important is that it is between the missions of the school the form individuals trained in skills cognitive type, skills, and attitudes towards the dangers and costs presented by the pollution and environmental degradation, in addition to form citizens capable of creating sustainable development need our planet. To do this it should be implicit and explicit in each and every one of the subjects that the teacher touched these issues, emphasizing its importance and interest for the formation integrate 21st century professionals. Matters dealing with these issues, not only in the trunks of specialization or terminals, but as obligatory subjects common to all engineers should certainly be included.

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