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RESEARCH ARTICLE

I Study to be an Engineer. Why to Study Administration and Accounting?

Yo estudio para ser ingeniero: ¿para qué cursar administración y contabilidad?

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Summary

Currently, cross-cutting subjects are promoted in the engineering curriculum to give added value to their graduates and to meet the new demands of the labor market. The main objective of the research work was to know the opinions of the engineering students about the level of contribution of the administrative-economic subjects in their academic training. Through a descriptive study with a qualitative approach, opinions of 23 engineering students were studied. These students studied administration and accounting subjects, which are part of the curriculum, during a year. It was found that the students show a very marked development of their professional identity as engineers, which determines their acceptance level of the subjects different from their professional profile, since they think they are useless. However, when the teachers adequately select the didactic resources and the teaching process adjusted to an engineering profile, students start to recognize the contribution of these subjects to their university education, which provide them with the foundations to face the new demands as future engineers in not only technical activities.

Keywords: Engineering training, engineering students, administration, accounting

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Resumen

Actualmente se impulsan temas transversales en el currículo de las ingenierías para otorgarles un valor agregado a sus egresados y para responder a las nuevas exigencias del mercado del trabajo. La investigación tuvo como objetivo principal conocer las opiniones de los estudiantes de ingeniería sobre el grado de contribución de las asignaturas económico administrativas en su formación académica. Mediante un estudio descriptivo con un enfoque cualitativo se estudiaron las opiniones de 23 estudiantes de ingeniería que cursaron durante un año las asignaturas de administración y contabilidad misma que forman parte de la currícula. Se encontró que los estudiantes muestran un desarrollo muy marcado de su identidad profesional como ingenieros lo que condiciona su nivel de aceptación de las asignaturas distintas a su perfil profesional, pues desde su imaginario no les otorgan utilidad alguna, sin embargo, cuando los profesores seleccionan apropiadamente los recursos didácticos y el proceso de enseñanza es ajustado a un perfil de ingeniería, los estudiantes empiezan a reconocer el aporte de dichas asignaturas en su formación universitaria mismas que les proporcionan las bases para enfrentarse a las nuevas exigencias como futuros ingenieros en actividades que van más allá de lo de carácter técnico.

Palabras clave: Formación en Ingenierías, estudiantes de ingeniería, administración, contabilidad.

Introduction

Nowadays, there is a global trend in multidisciplinary training in the field of higher education, i.e., it is intended that future graduates apart from being specialists in their field, they also know and apply methods and techniques from other areas or disciplines that serve them as a support so they can develop their career and profession (Damián, 2016). Since the 90s, some theorists have begun to talk about the breakup of engineering programs or professions purely of technical nature, and to identify the need to refocus the engineer training to become, according to Sáez (2004), a "sociotechnical engineer." Based on the foregoing and on the fact that current engineering students, who belong to the so-called Z generation, were born in the technology and internet boom, are characterized by being interactive and multifunctional, and who will have to face several difficulties to enter the labor market (Geck, 2006), the universities where they study should implement several strategies for the development of the teaching-learning process that provides them with not just technical training (Correia & Bozutti, 2017; Vega, 2013).

Labor Flexibility and New Demands in the University Training

The Labor Organization is currently characterized, according to Rodríguez (1995), by three aspects: 1) integrating the tasks instead of divide them, i.e. the specialization of the worker has moved to the background 2) giving the workers more participation in the conception, scheduling and evaluation of their own tasks through productivity and efficacy, and 3) organize the activities developed in a more balanced way in specific management areas in order to transfer them to the workshop or to the production lines. Given these new demands of the labor market, it is necessary to have a flexible workforce, situation that relates higher education to these demands (Rodríguez, 1995), that is, it is aimed at a human resource management policy based on polyvalence, flexibility and a greater qualification, which is implicitly correlated with a new educational policy (Neffa, 1993).

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For the designers of higher education policies, the above discussed is just an example of the changes that take place and that should be taken into account to define and organize university curriculum programs in order for them to be relevant, since they must provide the necessary conditions for the graduates to enter the labor market or to access other levels of training (Celis & Gómez, 2005; Klink, Boon & Schlusmans, 2007). The reforms of the education systems in universities, given these changes and demands of the labor market, are considered as the cornerstone in the training of a widely qualified workforce and as a central strategy to meet such demands (Hirst & Zeitlin; 1990,1991). Given this new scenario, Gibbons et al. (1994) says that a second mode of production of knowledge is gaining importance in today's society along with the traditional and disciplinary mode. The production of knowledge according to the second mode starts with problems in terms of application, for which knowledge must be mobilized, that is, must gather relevant knowledge from different fields of knowledge (multidisciplinarity) and it is often based on the intellectual work in collaboration with agents of different disciplinary areas or fields.

Teichler (1998) mentions when examining several proposals made in many countries by the group of workers, committees of specialists that study the future of higher education and researchers who analyze the connections between higher education and work, that these three agents conclude that it is expected that university graduates are multifaceted and have notions in fields of knowledge that are the basis of several professional capacities, for which it is expected that universities provide their students with more opportunities for interdisciplinary learning than in the past (Planas, 2014). Given these new demands in training of human resources that will be integrated into companies, in the 90's, the debate about the characteristics and possible changes in professional profiles that are offered by universities in this era of globalization, hyper-development of technologies and notable changes in the ways of work organization in companies was fueled.

In line with the aforementioned, Barrón (2005), when evaluating the different changes in the university curriculum in the Latin America context, says that unlike the past decade in which professional training was governed by the disciplinary advances and demands of the labor market based on a nationalist policy, in recent years, the principles of efficiency, efficacy and quality have prevailed. These principles are coined and emerged from the heart of the great company and are being expressed in the curriculum through the focus on the polyvalence, the mastery of cognitive strategies, of the application of conceptual and methodological tools, of the development of an anticipatory and proactive thinking and of an entrepreneurial sense in order to have graduates with a specialized and technical as well as multidisciplinary training. Taking into account the foregoing, it will be easy to understand why since the 80's, especially in industrialized countries, the need to adapt the existing professions to the new demands of the environment has envisaged (MEC, 1985), i.e. some traditional professions needed to be reinvented to continue generating work opportunities. The trends of change in some professions of the area of engineering are discussed below as a preamble to understand the drive given, from the national educational policy, to include specific and cross-cutting administrative and business topics in several engineering programs.

Engineering Programs and the New Demands

Some research works carried out in Europe in the 80's on the graduates from the area of engineering, concluded that the labor market "continues requiring engineers for strictly technical positions, but engineers with an additional training are preferred" (MEC, 1985, p. 38). Ruiz (1998), in a study carried out about the functions of the graduates from the industrial engineer program, whose professional profile was to conduct activities like supervise the productive processes in industrial plants, found that such profile in the field was modified according to the new demands of the companies, since a high percentage of these professionals assumed management positions

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in the economic-administrative area; six years later Ruiz (2004) conducted another research work on the same topic and he found that the engineering graduates had to face high personal, interpersonal and business demands in the development of their work activities, such results were confirmed by García and Romero (2011), who concluded that technical-administrative skills are demanded from engineers working in maquila industries; theses skills were not taught during their university education. By the year 2004, several professions faced problems due to the growing complexity of the environment, and to technical, polytechnic and socio-technical problems, the last ones stood out because "the technical dimensions of the previous categories were added to the multiple and most complex human factor and social categories, which require hybrid professionals" (Sáez, 2004, p. 2; Ruiz, 2004). It was evident the need to make changes, for that reason, Williams (2004) talks about the breakup of engineering:

> … engineering is disappearing as a consistent and independent profession characterized by its well-defined relationships and other social organizations, with the material world and with the guiding principles such as functionality; engineering survives in a hybrid world where there are no clear boundaries between the autonomous non-human nature and the processes generated by humans (p.40).

This refers to the fact the given the new demands, engineers cannot continue solving the problems only from the technical perspective, their occupations require a combination of technical, human and organizational knowledge, that is, "to prosper in a hybrid world, the new engineers should become hybrid" (Williams, 2004, p. 78). This represents a challenge for the universities, since they have to design and implement several teaching and pedagogical strategies to promote and develop administrative skills in students studying engineering programs, who reject these subjects since they cannot identify their contributions to their professional training. For the universities to make changes in the curriculum in order to train future engineers who meet the new demands of society and the world of employers, it is necessary to know the situation of the engineering professions in the

international and national arena, analysis that, for space reasons, is carried out concisely in the following sections.

Engineering Programs in the International Arena, their Characterization

According to the results of Capote, Rizo and Bravo (2016), from the analysis of several international reports, teaching engineering implies needs and demands for the training process to meet the context requirements, that is, it is required a teaching-learning process focused on the student and developed in an interactive and collaborative manner so the future engineer acquires knowledge for the whole life. Regarding the foregoing, Moreno (2007) mentions the need to train engineers with wide and flexible knowledge, with abilities and attitudes that allow them to meet their social responsibilities, that is, going beyond the mastery of exact sciences. To support the foregoing, Gómez, Castellanos and Delgado (2005), according to several documents, events and national and international experiences propose that the engineer should be a professional with:

1. Profound knowledge of basic, specific sciences and of their professional duties, with a general solid theoretical and scientific training.
2. Close relationships with the industry, with professional abilities to solve the most general and common problems of the social environment.
3. Integral, diverse and flexible training with particular emphasis on their communication skills, abilities to search, manage, process and use scientific-technical information, mastery of ICT, command of foreign languages, *economic*, ecological, humanistic training in general.

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4. Cultural training to develop human relationships based on professional, social, environmental knowledge, values and feelings, professional ethics and self-esteem.
5. A logic, heuristic, scientific, systemic thinking, able to model their ideas, flexible to assimilate changes rapidly.

To that effect, Restrepo (2007) states that it is necessary that the engineering curriculum includes the following basic components and ensures the scope of the following objectives:

1. Give preference to training in basic sciences: Mathematics, Physics, Chemistry and Informatics (learn to learn for life).
2. Specific training component with enough knowledge of quantity and quality in engineering in question (learn to do).
3. Include supplementary information in areas of *economics*, languages, social and *administration* (learn to be).

Several associations both public and private that are o have a close relationship with the professional work field of the engineering are focused on the engineer training with a more integral professional profile that faces the several situations or meets the demands of the market and the society. For instance, the Colombian Association of Engineering Schools (ACOFI, 2007), states that currently, society has great challenges for the professional engineers: sustainable development, growth, safety, scientific and technological advance, among others, and they are aware of the fact that in order to solve such problems, a new profile of engineer is required, that is, a profile characterized by a strong scientific training, intense interest in technology, wide and updated knowledge, innovative, creative, ability to communicate in several languages, with *entrepreneurial spirit*, ability to transfer technological advances and transform the inputs or raw materials into commercially viable products and services, reasons why new fields of professional performance for engineers have appeared: financial, administration and business management, medicine, public policy, just to

mention some examples,. UNESCO (2010) recognizes that engineering, as a human effort, faces numerous challenges of its own nature such as establish more interdisciplinary alliances with natural, social sciences and arts, improve the focus on innovation, *entrepreneurial spirit*, job creation, and promote public awareness to support the social function of engineering.

Engineering Programs in the National Arena, its Characterization

The current president of the Mexican Academy of Engineering (AIM, by its Spanish initials) in several opportunities has stated the need to establish a new profile for Mexican engineers so they can meet the society's demands, particularly of the group of employers. For that reason, it is necessary to include new skills and competencies in their traditional knowledge for a productive environment where the Fordist system is no longer the main way of organization (Rascón, 2010); that is, the scope of engineering shows different scenarios that require the transversal inclusion in technical and scientific knowledge of several *management skills* in order to train an engineer with a holistic approach characterized by a flexible mentality, solid theoretical and technical knowledge and, with *leadership* to lead work teams. Coincidentally with the foregoing, Smerdon (2000) says that the current engineer must coexist in several communities to address and solve daily and specific problems, for which the engineer must prove his *ability to communicate*, *work and lead multidisciplinary teams*, to be full aware of the social, ecological and ethical implications of the engineering projects.

In order to structure the new curriculum for the current training of the Mexican engineer, Rascón (2010) lists a group of knowledge, skills and abilities required for engineers to meet the current demands of the work sector, and four of them correspond to the economic-administrative area:

1. Theoretical knowledge of mathematics, physics, chemistry, biology, mechanics, materials, sciences of engineering, *economics*,

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humanities and social sciences, and the way to apply them to solve several problems.

2. Abilities to plan, design, construct, supervise, keep and operate structures, facilities and several systems with an approach to economic, social and environmental sustainability.
3. Be innovative to integrate their proposals, ideas and technologies in several fields of the society in the public, private and academic sector.
4. Ability to face and manage risk and uncertainty caused by natural events, accidents and other accidental situations derived from the exercise of their profession.
5. Show leadership in the discussions and decision on the design of public policies that have to do with their area for the collective benefit.
6. Ability to design, carry out and interpret field works and experiments in several contexts according to the area of their specialty, as well as in workshops and laboratories.
7. Capacity to use a systemic approach to diagnose, formulate and solve specific and general problems with a sense of social responsibility.
8. Know, understand and evaluate the impact of the engineering projects in global and social contexts.
9. Show good attitude and willingness to learn throughout their professional life to be aware of innovations in their area of specialty.
10. Capacity to use modern engineering techniques, tools and methods.
11. Develop and show entrepreneurial skills, as well as creativity and administrative management skills.

12. Management of information and several data with great perception to interpret several circumstances about the economic, social and productive environment.
13. Know how to communicate perfectly in Spanish and command other languages such as English to communicate with technical and non-technical people, either orally or in writing, making use of audio-visual materials.
14. *Show capacity to exercise leadership to work and coordinate other heterogeneous and multidisciplinary groups and in different places, situations and contexts*.
15. Capacity to master ICT in their field of professional performance.
16. Apply a critical and assertive thinking in their professional performance, with a competitive, prospective and proactive mentality.
17. Act in their professional and work practice with professional ethic, responsibility, commitment, values and service vocation.

In addition to the foregoing, the Secretariat of Public Education of the country (SEP, 2015), in the last study about engineering studies, reported that the enrollment in these programs has increased by almost one million students (more than in the Unites States, Japan and the European Union). However, such increase of enrollments is causing several challenges and opportunities for the higher education policy makers of the country, as reported by several diagnoses carried out by the Accreditation Board for Engineering Education (CACEI, 2014), among which three great challenges stand out: challenges related to enrollment, training process and to the field of professional performance. Regarding the first one, there are:

1. A lot of engineering programs with different definitions (916 names and 5,658 different programs).

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2. Many different training profiles and models according to the university, even when they have the same name (ASME, 2011).

3. Low terminal efficiency and high failure of students in basic sciences.

4. Growth and expansion of the enrollment in new areas of engineering (information technology, robotics, mechatronics, oil, renewable energies, automotive, aeronautics, biomedicine, biotechnology, nanotechnology, environmental, among others) and reduction of those that highlight the economic development of the country (Álvarez, 2014)[1]. In addition to the foregoing, since 1999, engineering programs have been strongly promoted in the country in the areas of companies and businesses (business management, innovation and development of businesses, finances and administration), especially in higher education subsystems of technological nature such as the National Institute of Technology of Mexico, the las Polytechnic Universities and Technological Universities, three subsystems with presence throughout the national territory (Damián, 2017).

The second group of challenges is related to the engineer training process in which there is an incipient link to the production sector since they rarely involve the development of competencies of the students by providing real learning scenarios in the facilities. A large number of engineering programs does not include study practices during and throughout their education. Students are limited to do a short activity when they complete all the academic credits in a program called vocational placement, internship, among other names (Martínez, Damián & Rodríguez; 2018). Regarding

1 As an example, Dorador (2014) talks about the programs derived from Mechanical Engineering grouped in five groups: 1) Manufacture engineering (areas: design of tools, improvement of processes and design for assembly and manufacturing), 2) Material engineering (areas: composite materials and plastic materials), 3) Design engineering and mechatronic design (areas: design of products and design of machinery and equipment), 4) Thermofluid engineering (areas: control of emissions and fluid flow and particulate modelling) and 5) Mechatronic engineering (area: industrial automation, industrial control of processes and robotics).

> social services, they are developed in governmental agencies of the three levels of government, carrying out very different activities that are almost unrelated with the engineering studies. Therefore, it is easy to understand the causes why employers say that graduate engineers have limited knowledge of main techniques, procedure and equipment required for their professional performance.

The third challenge represents the field of professional performance of the engineer and its definition from the structure of curriculum. To that effect, it is necessary to include in the curriculum several topics that ensure a solid training in basic sciences and engineering sciences that help to increase the employability capacity and therefore, a rapid labor insertion. In this regard, the problem lies in a discussion about the demarcation of the work of engineers, we will call the first one classic or traditional and it considers this profession as "design engineers" who, through their theoretical and practical knowledge in exact sciences, seek how to improve, innovate and develop goods and products or to solve problems of their area of interest, while the second one, which is more modern, considers them as "management engineers", that is, they concentrate their knowledge and experience on managing projects, people, work teams and companies. Damián (2018) calls the first group "overalls engineer" whose functions are mainly techniques and he calls the second group "white coat engineers" who assume administrative functions, invading labor fields of other professions. Then to meet these three great demands, CACEI proposes a training model for the engineer in Mexico (Table 1), which must be structured into five main axes, respecting the curricular and institutional-pedagogical models:

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Table 1.

Axes proposed for the training of engineers in Mexico

Axes	Description
Basic sciences	Solid knowledge and skills of theoretical concepts and solutions of basic sciences (mathematics, physics, chemistry) that enable students to use mathematical tools and skills, spatial logic skills, reasoning skills, to predict and analyze scenarios, analyze data and understand the chemical and physical phenomena to solve engineering problems.
Engineering sciences	Set of technical and methodological tools of different disciplines or engineering branches that provides the solution of problems of basic and general engineering, for which a proper knowledge of basic sciences and an understanding of the social, ethic, economic and political context of the environment are required.
Applied engineering	Set of knowledge and skills that allows students to identify and solve a specialized problem of an engineering branch, for which they have to use four previous axes in an environment of competitiveness, efficiency, adhering to the ethical principles and engineering standards.
Economic-administrative sciences	Knowledge and skills of the economic-administrative area that allow students to understand the impact of the economic environment on the engineering projects, and to plan, manage and administrate and control projects and processes as well as to evaluate and interpret results.
Social sciences and humanities	Disciplines that study the manifestations and behaviors of the society and the individual that provide the future engineer with knowledge and skills to understand and analyze how things work, the context and the individuals and to develop humanistic, ethic, social and individual skills through the study of philosophies, theories, concepts and elemental solutions focused on the social, humanistic and economic problem in the current world.

Source: taken and adapted from CACEI (2014).

Related to the foregoing, Covarrubias (1998) says that in the country three source documents have been used as a guide to make modifications in the curriculum of the engineering programs in aspects related to training, values, activities and the exercise of the profession (Table 2).

Table 2.

Main documents for the integration of the engineering curriculum.

Name, source and year	Contributions to the engineer training
"Technology and Economy. The Key Relationships", OCDE, 1992.	The conceptualization of engineering branches is discussed taking into account its place in the field of knowledge and of professions. Two groups of sciences are distinguished: pure and transformation, the former are focused on exploring the theoretical knowledge boundaries without worrying about its application level. The latter are focused on solving problems arisen from the social and economic activity. It is concluded that the engineering branches have no specific delimitation and they move around pure and transformation sciences. For that reason, future engineers need a multidisciplinary training to contribute to meeting social and economic need through several engineering branches or fields.
"Proceedings of the Congress on Engineer Training", UNESCO, 1997.	Specialists from all parts of the world discuss the engineer training and propose a list of attributes that should have this professional and some of them are, according to the objective of this work, creativity and spirit, innovative, ability to communicate and multidisciplinary training; to which we must add the ethics training for the respect of values and environment in general.
"Values Project". COPARMEX, 1997.	Since many engineering professionals work in private companies and others are entrepreneurs, an ideology based on values is proposed since given the moral crisis, it is urgent to return to values, so engineers must fulfill their social functions in the framework of a set of values accepted by the society.

Source: prepared by authors with Covarrubias's data (1998).

Regarding the foregoing, it is recognized that in our country, public universities have lagged behind the development of a curriculum for the engineering areas that include administrative and financial topics. Only private elite universities are greatly promoting this policy[2], offering studies such as administrator chemical engineer who is a professional that designs, operates and administrates the chemical processes to promote sustainable development based on the application of natural sciences and engineering, considering the productivity, technological development and profitability of the organizations, and is able to model, develop and improve chemical processes and products taking into account technical, economic, social, cultural and ethical considerations (ITESM, 2018); or the administrator mechanical engineer who has solid training in sciences and

2 Among the most outstanding higher education institutions in this group are the Technological Institute and Higher Education of Monterrey, Ibero-American University, Anáhuac University, La Salle University, University of las Américas, Autonomous Technological Institute of Mexico.

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engineering, specialized in areas related to design, installation, operation and maintenance of mechanical systems; the integration of manufacturing and the administration of production processes, for which this engineer correctly use production engineering, the financial aspect and the sustainable development (ITESM, 2018).

Damián (2018) says that public universities seem to train "overall engineers" and the private universities seem to train "white coat engineers", that is, the former have a merely technical training to carry out hard work in their specialty and the latter can also easily assume management positions and great responsibility in organizations where they work. Recognizing the foregoing, some higher education subsystems in the educational programs of engineering sciences have included certain subjects of economic nature with two purposes: 1) lay the foundations of the principles of business entrepreneurship and 2) develop basic administrative skills in graduates that may be required in their professional performance (Romero, 2013).

In the specific case that concerns us, the University of Papaloapan (UNPA) belonging to the System of State Universities of Oaxaca (SUNEO), following the policies of such system, establishes that in all engineering programs, the curriculum should include four to five subjects of economic-administrative nature (Seara, 2010). It is should be noted that teachers with such professional training are not attached to such programs, the subjects are taught by teachers (accountants and administrators) who belong to the Business Sciences Degree Program, who are asked to support the delivery of classes. According to the conversations held with these teachers, a very common situation was identified between engineering students: they feel apathy and discouragement towards the economic-administrative subjects and they say they are studying to become an engineer and that there is no sense to study theses subjects that do not belong to their program and they do not know their level of contribution to their academic education, for this reason, it was decided to do a research wok on such situation in the students from two engineering programs offered by the UNPA. Since it is

easy to understand that negative opinion, perception or attitude of students towards the inclusion of economic-administrative subjects in their training in engineering, this causes two situations: teachers has difficulty to teach such subjects to their students who disagree with such training and, little use of the contents of such subjects by the students, which is caused by the fact that they are not interested in them. The main objective of the work is to know how engineering student perceive the economic-administrative subjects that are part of the university curriculum in terms of the level of contribution to their academic education and future professional and work development and, secondly, to know how they evaluate the teacher's work in terms of development of contents of such subjects in order to be able to make didactic proposals in the future.

Method

Type of Study and Participants

The study was descriptive using a qualitative approach. Since the small number of students enrolled, it was decided that they all participate in the study as recommended by Hernández, Fernández and Baptista (2014); those participants were in the sixth and seventh semester of the Food Engineering and Biotechnology Engineer programs offered by the University of Papaloapan. It is worth mentioning that due to the small number of enrollments in the semesters of the two programs, the 23 students were gathered in a single classroom for classes. Table 3 shows the structure of each program, as well as the subjects of the economic-administrative area that are included in their curriculum.

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Table 3.

Characteristics of the participants in the study.

Program	Number of students	Subjects of the economic-administrative area
Biotechnology Engineering	11	Administration*, accounting**, marketing and, formulation and evaluation of projects.
Food Engineering	12	Economic theory, administration*, accounting**, Administrative structures, formulation and evaluation of projects and, general management.

* Studied in sixth semester; ** Studied in seventh semester

Source: prepared by the authors with research data

Way of Development of the Activities during the School Year

The first day of classes before the selection of the course, a plenary session was conducted. In this plenary session the students were required to express their opinion about the subjects of the economic-administrative area that they would study (the results of the plenary session are discussed in other document), in order to obtain information to adapt the contents and select the didactic strategies that would help the students to break their paradigms with respect to the usefulness of this type of subjects in their training in engineering. In general terms, they commented that these subjects did not have any value for them, they are useless, they are "filler" classes, and that according to what the students of more advanced semesters, the classes were boring and that the professors treated them as if they were students from the Business Sciences Degree Program (program to which teachers are attached).

Conversations were held with some teachers who in the past worked with engineering students and it was found that they use the same didactic strategies to develop contents as they do with the students from the Business Sciences Degree Program and that the bibliographic resources are basic textbooks for the training of the administrator or accountant.

With the foregoing, adjustments were made to develop the contents of the subjects. It was decided not to use textbooks for accountants and administrators and they were replaced by others books that were more consistent with their profile. Two textbooks were used throughout the administration course: 1) "Administration for Engineers" by Miguel Rojas edited by the National School of Mines of the National University of Colombia, that throughout the text the author uses the term "administrator engineer", highlighting that as time elapses in their career, every engineer needs to know and apply concepts and techniques coming from administrative and business sciences, and 2) "The Seven Habits of Highly Effective People" by Stephen Covey, which approaches the importance of knowing and applying principles for building self-confidence, character, integrity, honesty and human dignity as basic inputs to transform our work, social and personal environment. For the case of the Accounting course, the books used in the accountant's training were no longer used and several materials designed as manuals for participants in courses and workshops on "Accounting for not accountants" were used. These courses and workshops were aimed at people not expert in the topic or without any academic education, but they allow them to know everything they need about accounting technique without difficulties and without the obsession of a specialized class or doing it in an unexciting manner, but without forgetting to teach the aspects that are important for the administrator engineer.

Data Collection Method

At the end of the two semesters, the students were asked to write a free essay of two pages maximum where they could express their opinions on the benefit of the economic-administrative subjects to their professional and work training. This activity was carried out once all the tests were completed in order to prevent bias in the students' opinions due to fear of possible reprisals for their comments. The essays were sent to the teacher's e-mail who collected and organized them for reading and analysis.

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Information Analysis and Processing

All 23 essays were read in order to have a very general knowledge of the students' opinions and to begin to identify patterns of opinions. In a second reading, the categories of analyses were identified which allowed evaluating the sense of the students' opinions about the level of importance they gave to the administration and accounting classes (Fox, 1981; Espín, 2002). An interpretation of what they manifested was made using the fragments of the students' opinions as they expressed them in their essays. For this purpose, the students' name is placed in each fragment, followed by the acronyms BE and FE according to the program they are studying: Biotechnology Engineering and Food Engineering. A latent interpretation was also carried out trying to interpret, construct, and give meaning to the students' opinions through the existing theory on the subject such as said by Alvarez-Gayou (2005) and Bogdan and Biklen (1992).

Results

The results obtained are shown in six sections that refer to and describe the same number of categories that emerged from the analysis of the content of the students' essays. To begin with, table 4 shows the categories summarized and the number and percentages of references that were made of them according to the students' programs.

Table 4.

Reference to the categories according to the students' programs.

Categories	Number of references and percentage (%) per program	
	Biotechnology Engineering	Food Engineering
Classroom work	3 (27%)	9 (75%)
Benefit of the subjects	8 (72%)	3 (25%)
Professional Identity	6 (54%)	2 (17%)
Career aspirations	4 (36%)	1(8%)
Subject Objectives	3 (27%)	1 (8%)
Preconceptions	3 (27%)	2 (17%)

Source: Prepared by the authors with data from the research.

Category 1. Preconceptions about administrative economic subjects.

This category shows that students have negative or erroneous preconceptions about the economic-administrative subjects before taking the classes. Knowing this is important for the teaching work because according to Martínez (2004:181), the attitude refers to "fundamental conceptions relating to the nature of the human being, which involves certain moral or human components, requires personal commitment and is defined as a tendency or constant willingness to perceive or react in a given sense, namely: tolerance and intolerance, respect or criticism, trust or distrust, etc." Thus, some students acknowledged that studying these subjects represented a challenge to their preconceptions, as in the case of Erick and Azucena, students from the Biotechnology Engineering program who mentioned the following:

> *Honestly, I had never liked the administrative area. I was one of those who said "I'm going to be an engineer, that doesn't help me", but as the classes were progressing, I realized how important it is today to have knowledge of these areas (Erick, BE).*
> *At the beginning of the administration class, I didn't feel very comfortable with the subjects of administration because I didn't understand them and because it was something different from what I was used to hearing (Azucena, BE).*

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It didn't represent any challenge for other students, it was simply something different or out of the ordinary to take this type of class, as referred to by this student from the Food Engineering program:

> *... everything started with curiosity for something new and a little bit of fear. However, the subject was very interesting because [the teacher] had a very efficient way of explaining it (Paula, FE).*

However, as reported by Romero, Utrilla and Utrilla (2014), the results show that these initial preconceptions of a negative nature changed as the subjects were developed according to the working method explained in the methodology section, that is, engineering students who initially showed negative attitudes towards the subject and the teacher, were able to understand that studying these subjects provide them certain benefits, among which they pointed out the following:

> *[At the end of the course] you see the problem from a different point of view. You even realize other things that at least I didn't know (Eliza, FE). Taking this class helped me a lot because now I take into account the other working areas. At the beginning, I had the idea that an engineer could only work in technological production processes, machine maintenance and things like that, now I understand that for many engineers the success of the career can be to obtain a leadership position, a position of higher hierarchy (Mayra, BE).*

Category 2. Benefits Attributed to the Administrative-Economic Subjects.

This category is subdivided into three groups according to the type of benefit attributed by the students: personal, academic, and professional-work. The fact the students find a sense to these subjects is considered a key factor in order to successfully study and use the subjects' contents which are far from the engineering subjects. Finding a sense to these subjects is also a motivation for learning (Tapia, 2005). According to Covington (2000) and Eccles and Wigfield (2002), students usually tend to face their schoolwork

with more or less interest and effort due to three factors: 1) their perceptions about the usefulness of learning the subject proposed, which depends on their particular goals, objectives, and interests; 2) their expectations for successfully coping with the difficulties to acquire the knowledge proposed by the teachers, and; 3) the costs (time and effort) which must be invested in order to achieve the desired learning outcomes. As for the personal benefit, it was found that some students consider that the economic-administrative subjects provided them with practical tools and advice to plan and organize their various personal activities, for the correct administration of their monetary resources, and even to generate the idea of an own business within their engineering area, as referred to by the following students (table 5):

Table 5.

Personal Benefits Attributed to the Administrative-Economic Subjects.

1.	From my point of view, it is important to take this class as a basis for self-organization or planning. Also, the knowledge acquired will be important for the future for our self-development and especially because we learn new techniques and ways of working that can contribute more to productivity (Paula, FE).
2.	I think it is a subject that is applied in a good way so that we, as students, have an idea of how best to manage our money, time and skills, and to have the knowledge if we want to be entrepreneurs in the future. There are many aspects that I did not know and that makes you realize that having this knowledge would help in your business no matter how small. Each point addressed in the subject was very useful because it gives you a vision by giving you different examples that are easy to understand (Rosa, BE).

Source: Prepared by the authors with data obtained from students.

On the other hand, it was found that the students mentioned that the economic-administrative subjects have an academic benefit as a factor of added value in their training as future engineers since they now allow them to understand the business situation more broadly. (table 6):

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Table 6.

Academic Benefits Attributed to the Administrative-Economic Subjects.

1.	… although my major is focused more on the production area, the development of new products, food quality and safety, it is equally important to take subjects of an administrative area, such as accounting, general systems theory, and administration. (Karen, FE).
2.	… I think that engineers undergoing training are given a better picture of what they will face in the company's real life. That's why I agree with the globalization of engineering majors in the academic aspect, looking for new subjects to train a human engineer that will learn how to treat people under their command and lead them down the path of optimal production of the Company (Jorge, BE).
3.	I believe that new knowledge, such as the administrative knowledge given to engineers, is part of the current working lifestyle, since just as there are advances in the industries to have greater efficiency in production, in [educational] institutions there are also modifications in the educational models that are linked to the requirements asked by the industries and to broaden the knowledge of engineers (Azucena, BE).
4.	These classes are of great use for a better organization within the company, and in this way, to keep track of everything you want from the beginning. That is to say, each company or industry has an objective, a mission, and a purpose. For this reason, the correct decisions must be made from the perspective offered by the administration, and all this could be achieved with teamwork, using knowledge and skills of each member. It is here where you could say that both parties win because when you achieve something, for example, in the food industry, when the product is launched to the market, there would be higher profits and employees would receive a better salary (Zenaida, BE).

Source: Prepared by the authors with data obtained from students.

In a third group, some students mentioned that the administrative-economic subjects represent a professional-work benefit because they now understand that in their field of professional performance as engineers it is necessary to have a basic knowledge of this type of subjects that give them an added value to their professional training as shown in the following comments (table 7):

Table 7.
Professional-Work Benefits Attributed to the Administrative-Economic Subjects.

1.	It is important because ... the engineer's activities and roles in today's companies are diversified, so an engineer must have a multidisciplinary and comprehensive knowledge to meet that demand. Also, it is an indispensable requirement that companies ask for today, since companies, as well as technology, are constantly changing and restructured to be efficient and compete in the market. Therefore, we, engineers of these new times have to adapt to these demands and be prepared for the demands generated by this constantly changing world (Eliza, FE).
2.	It is important for us engineers to take economic-administrative classes to strengthen our profession. I would dare to say that we are more efficient than many people who have an administrative major. We can even perform better after we have had a work experience because with the knowledge of these subjects, it will be easier for us to interact with other people and transmit the information to them (Eligio, BE).
3.	The importance of administrative courses lies in the multidisciplinary nature of the engineer. As a student, it seemed unnecessary to me, but through time I understood that it is necessary and fundamental to have a complete quality training not only for myself but for the good of the society that surrounds me, to stand out and to be better every day. Knowledge is a virtue and it is never bad to learn more, apart from the fact that, by having this knowledge I can achieve a better working position (Leo, BE).
4.	In the new occupational and professional engineering positions, the importance of the economic-administrative knowledge approach stands out, because it prepares engineers to be more predisposed to perform the tasks performed by white-collar and clean-handed engineers. Engineers who received this knowledge state that they have a better preparation and attitude to take responsibility for those activities that have little to do with the knowledge established by the engineering discipline, and that demand shallow technical knowledge and wide variety of social skills, necessary in the development of social capital that is beneficial both to the company and to the engineer (Mayra, BE).
5.	… so we will have more job opportunities because we can work in any area of the company, obviously not as someone specializing in that area, but companies are never willing to spend more than they estimate. Therefore, they will hire an engineer who can fulfill two functions: engineering and organizing the people under his or her charge (Jorge, BE).
6.	In my opinion, taking administrative-economic classes is an extra tool for engineers to carry out [other jobs], to have a broader vision of what is happening on the other side of the coin in the company. However, it should not be something in which the engineers devotes all their time since their knowledge is required more in production (Azucena, BE).
7.	… that is very important for our foundations as engineers because... engineers need a little more group cohesion, learn to work as a team because they are the strengths that are likely to be present in a company even at a professional or working level. Getting along with co-workers brings harmony (Keyla, BE).

Source: Prepared by the authors with data obtained from students.

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Category 3. Objectives Attributed to the Economic-Administrative Subjects.

This third category refers to the students' level of knowledge of the objectives pursued by the study program by incorporating economic-administrative subjects into their university curriculum. This is considered favorable because if students acknowledge that the objectives are the main purpose of the educational act, and that they relate to the skills or competencies that they are intended to develop, students will be more willing to address and study the specific contents of these subjects as referred to by Murillo (2010). Thus, for some students especially for those from food engineering major, this type of subjects is aimed at promoting an entrepreneurial culture, so that when they graduate they will identify business opportunities through the integral use of the diverse resources available in the region as they expressed as follows (table 8):

Table 8.
Entrepreneurship as an Objective of the Administrative-Economic Subjects.

1.	… I know that teachers teach us subjects outside our major program with the goal that if we do not want to work for a boss, we can be our own bosses either by improving or developing an innovative product or providing a service, whichever our idea is (Karen, FE).
2.	… I get a good impression of the course because although it is not directly related to our engineering profile, it is good and essential in our training. Now I have the knowledge to make my own business when I finish and that pleases me. They should add more similar subjects to help you open your mind and not only with the idea that you are just aimed at producing (Jorge, BE).

Source: Prepared by the authors with data obtained from students.

Another group of students refer to what Salcedo (2011) says, in the sense that they are aware of the fact that the objectives of this type of subjects not only refer to didactic formulations, but also to the expected changes in their behavior as an effect of the learning-teaching process, generating the development of another type of knowledge and skills that allow them to broaden their professional working field as engineers in the working world, as shown in the following comments (table 9):

Table 9.
Broadening the Working Field as an Objective of the Economic-Administrative Subjects.

1.	The purpose of these subjects is that engineers consider that they can perform at least two types of administration: one referring to technical administration, that is, linked to production, responsible for designing the necessary logistics in the production process, and the second type would be related to the administration, that is, the company's general management and some of its areas: marketing, purchases, and relations with suppliers, human resources, etc., whose performance would require mastery of other knowledge and greater doses of social skills (Mayra, BE).
2.	Administration is a way to plan, organize, have a direction and keep track of goals, all this in order to better exploit the company's resources. For this reason, it is important that engineers acquire knowledge in this area to improve their learning skills and to be able to obtain a quality job (Zenaida, BE).

Source: Prepared by the authors with data obtained from students.

Category 4. The Engineer's Professional Identity

This category helps us to explain the reasons why students are reluctant to study the economic- administrative subjects. Even though students have taken little more than 50% of their engineering credits, they have strongly developed a sense of belonging to it. It means that they show a very marked professional identity understood as that representation that is created around a specific field of work which is recognized in society, and among a group of individuals who identify themselves as members of this group, whose characteristic is to share this social representation of the profession and their sense of belonging (Ávila and Cortés, 2007). In this sense, the students assume a professional identity with a firm position, considering the administrative-economic subjects as intruders or as subjects with little value for their education as engineers, as they categorically express it as follows (table 10):

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Table 10.
Economic-administrative Subjects Antagonistic to their Professional Identity.

1.	… I think that when you study engineering you only get to know the improvement of processes. Knowing how to improve the process of something to get a better product or what you want to get is what we are taught in the institution: where I am, how to be an engineer. (Aridaith, BE).
2.	… an engineer will not be working full time in the administrative area, ... engineers should only be in their area and not out of it, that is to have respect for engineers (Eligio, BE).
3.	… before being anything else "we are or will be engineers", and as such, the main function of an engineer is to solve problems accurately and effectively regardless of the method to be used, for this reason the multidisciplinary nature of our career is necessary to perform those tasks that are imposed on an engineer (Leo, BE).
4.	The word engineer has always caused admiration and respect in society because they are academically well-prepared people and are exclusively linked to tasks related to innovation, design and operation of technologies in society,… but subjects like: administration, accounting, etc., can be included, not as specialized subjects, but as one-semester courses just to have the [basic] knowledge of everything that is done in real life in a company. Therefore, it will generate quality engineers, so that when they face some administrative problems, they will have the idea of how to solve it (Jorge, BE).

Source: Prepared by the authors with data obtained from students.

In this category we also found students who assume their professional identity, but show a soft or tolerant attitude to the fact that they have to take administrative-economic subjects, that is to say, as mentioned by Miejers (1998), when the student is fully aware of the major he is studying or knows the role of his professional training, this will transmit security to him when graduating because he knows the different activities, positions, or working areas within the companies. In the present case, as found in some studies with university graduates with multidisciplinary training (Damián, 2016), some students considered that these subjects give them an added value to their university education that will be useful for their field of work, as shown in the following comments (table 11):

Table 11.
Economic-Administrative Subjects and their Contribution to the Professional Identity.

1.	Taking economic-administrative classes allows us to learn different aspects of this area. Although we will not specifically have to work in this area, it provides us with a basic knowledge to interpret situations or administrative problems related to our working life (Paula, FE).
2.	… in a company there are as many engineers working in the administrative area as engineers in charge of carrying out the specific tasks of the production process, the handling of machinery and equipment, maintenance and supervision activities, the "dirty work", that is, those who are in charge even of some administrative tasks, focused only on the productive process, without going beyond what the industrial plant demands (Mayra, BE).
3.	For the engineers' work, regardless if it is in the Industry or in their own company, they indisputably must be qualified to implement techniques to simplify work, to plan, organize and control the production of goods and services in optimal quality conditions, as well as to efficiently manage the available resources in order to increase productivity, performance, and profitability,… fortunately, all of us who are involved with the engineering area must always keep in mind that: it is easier for an engineer to be an administrator than for an administrator to be an engineer (Erick, BE).

Source: Prepared by the authors with data obtained from students.

Category 5. Career Aspirations

In this category, it was found that although students present a good level of development of their professional identity as future engineers, they are aware of the fact that administrative-economic subjects will play some important role in their working field, that is to say, their opinions agree with what is said by Pastor, Peraita and Zaera (2013), in the sense that including those subjects in their university engineering studies, not only trains them as a human capital but also increases their productivity and attractiveness for companies, increasing their employability, as commented by some of them (table 12):

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Table 12.
The Economic-Administrative Subjects and their Contribution to Employability.

1.	… I think that our education system has focused on training quality students not only in the engineering field but in other areas that help us to be better every day. This is because others' opinions have been taken into account, that is, the opinion of companies where we will work when we finish our studies (Karen FE).
2.	The industry or companies want someone who has economic-administrative knowledges. So, in order for us to find a job and compete for it with others we must have more knowledge in that area. Therefore, it is important to take this type of classes for every engineer who wants to work in the industry (Aridaith, BE).
3.	… it is important to have administration knowledge since the industry is requiring qualified engineers in these areas, and having a more complete education gives us more opportunities when looking for a job, compared to only having the engineer identity as a technological expert separated from the administration area (Erick, BE).

Source: Prepared by the authors with data obtained from students.

On the other hand, other students think that economic-administrative subjects add value to their engineering studies because they think that they can have positive effects on the tendency to entrepreneurship and that they increase the probability to reach management positions coinciding with what is stated by Congregado et al (2008). In this regard, the following comments were made (table13):

Table 13.
Economic-Administrative Subjects as an Added Value for the Engineer.

1.	… the administrative area, where the decision-making takes place, is of a greater prestige for an engineer. Getting to work in this area would be a great success in the career of an engineer (Mayra, BE).
2.	I want to work in the industry and this gives me more points to aspire to a higher position. The combination of the administrative, technical and scientific areas taught at the university will be our best tools to compete with engineers from the country's most renowned public universities (Erick, BE).

Source: Prepared by the authors with data obtained from students.

Students rarely agree with Pérez et al (2012), considering that the economic-administrative subjects in their university education would generate in the future positive effects on the characteristics of employment

or work, that is to say, more stable jobs, less risk of unemployment, less unemployment duration than average, and more possibilities to obtain contracts for indefinite duration as indicated by the following comments:

> *The economic-administrative subjects in the engineering programs stand out for the fact that there would be a greater employment opportunity in the industry, that is to say, a safe job with good benefits (Zenaida, BE).*

Category 6. Work in Class

It is interesting to know the opinions of students on how to develop the contents of the economic-administrative subjects, so that teachers take them into account as inputs for the planning and development of these subjects in subsequent generations. The students were, therefore, asked to express the good and bad of the course, what they liked or disliked, and their recommendations for teachers. The students' comments were classified into three groups and are shown in the following tables:

Table 14 shows that the teacher's way of teaching the contents of the economic-administrative subjects was favorable because the majority of the students liked and commented on the teacher's performance. This is important because, as Elliot (2000) states, when assessing the teacher's performance, students, in addition to mentioning the technical mastery the teacher has in the area, they should include the general guidelines used in the classroom, as well as the concern for the students' learning. Taking into account the foregoing, the students refer that the teacher was patient and that the demand level was adequate because the teacher took into account that they are not students of the business area and therefore, the teacher did not demand the development of activities that go beyond the basic knowledge of the courses. Also, the students indicated that the topics were approached with very simple explanations and using examples of personal work experiences for a better understanding of the topics.

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Table 14.
Comments on the Teacher's Way of Working (Didactics).

	Teacher's Didactics
3.	Let me thank you for being very patient and for what I learned, it was a dynamic and very interesting subject (Paula, FE).
4.	The development of the subject was smooth and very pleasant (Eligio, BE).
5.	The teacher's way of transmitting the message was always very clear and concise. The work experiences shared by the teacher to support the subjects made it a more pleasant class. The interaction with the group and asking for our opinions made us think reasonably about the response to what was required (Rosa, BE).
6.	That the teacher talked a lot, ha hahaha, that's a lie, that was a good thing because the teacher showed a mastery of the subject and managed to teach the subject in a better and excellent way (Leo, BE).
7.	The topics were very well addressed with clear explanations (Mayra, BE).
8.	I'm happy with the subject because the teacher made it easier for us to learn, with clear examples and interaction with everyone (Jorge, BE).
9.	An example was given on each topic. Personally, it was a good way to find a direction or interest, because everything was based on lived experiences that allowed us to go further, that is, to imagine ourselves in the future in these conditions (Zenaida, BE).
10.	A company consists of a leader and its employees. I think [the teacher] was a good leader because we participated in class and clarified many things that we did not know about (Keyla, BE).

Source: Prepared by the authors with data obtained from students.

The good comments on the teacher's way of working according to the previous table are perhaps the result of the series of didactic resources used in the development of subject contents, understood as "those material elements, function of which is to facilitate the communication established between educators and learners" (Colom et al, 1988:16). Table 15 shows that from the point of view of future engineers, the teacher who cared about their learning used four important resources (Salinas, 2002): presentations supported by videos or films on the subject, group dynamics in order to experience and internalize leadership, and effective communication topics, examples of the organization and operation of some important companies in

the local environment or context that students know or identify, and written material on the subject but focused on engineering.

Table 15.
Comments on Teaching Resources Used in Class.

	Teaching resources
1.	The classes didn't become tedious. It was good for everyone to discuss a topic because that's how we work more and also because the classes were more explanatory [with videos] rather than just reading or watching slides because that's boring (Eliza, FE).
2.	I liked to present a project because this way I could let my classmates know what I had understood of the subject. I liked when a classmate included a very cool dynamics in her project presentation (Aridaith, BE).
3.	Being didactic in class made you de-stress and relax, the presentations and the movies or videos managed to make us work as a team with students from other programs (Rosa, BE).
4.	I liked that the teacher gave us examples about the topics covered and how they related to our majors, as well as explaining how some companies in the region are organized (Azucena, BE).
5.	There was a lot of quality topics thanks to the booklet of "administration for engineers" which helped us to understand the basic topics of administration,... and the dynamics that we carried out were very helpful (Keyla, BE).
6.	Even the small exercised carried out gave us enough knowledge about the subject (Zenaida, BE).

Source: Prepared by the authors with data obtained from students.

Despite the fact that the students rated the teacher's performance in a satisfactory manner, Table 16 shows the comments that, from their point of view, they consider important that teachers of the economic-administrative subjects in engineering programs take into account in order for the students to obtain a better use of said knowledge, that is to say, as stated by Feldman (1999), the students suggest that teachers should plentifully use four didactic resources, the first three within the classroom, such as the use of more group dynamics to strengthen understanding of the topics, encourage discussion and group debate about the topics, and develop a microenterprise as part of the work of a school project. With respect to activities outside the class, they suggest planned visits to some companies in the geographical environment so that they know their way of organization and operation, and corroborate the

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relationship of economic-administrative issues with engineering positions and functions.

Table 16.
Suggestions for Improving the Teaching-learning Process.

	Suggestions
1.	I would have liked that they became more dynamic so as not to get bored in class, or that the classmates showed images in their presentations, since just a copy and paste presentation doesn't help much. It would have also helped that classmates had given examples of what they were saying, and it was also necessary that the audience speaks and not only the speaker because it is boring to listen to only one person (Eliza, FE).
2.	My recommendations are to include more dynamic exercises to motivate the students, as well as including participation in class so that they can participate and pay more attention, but also to include dynamic exercises such as debates between the whole group divided in small teams so that each team could give its opinion (Aridaith, BE).
3.	We needed a team project to make a microenterprise, so we could define ourselves as entrepreneurs, we could even give an example of how to perform such tasks (Eligio, BE).

Source: Prepared by the authors with data obtained from students.

Discussion and Conclusions

The emphasis on cross-cutting subjects in the engineering curriculum corresponds to the new ways of work organization that demand polyvalent and flexible professional teams, as mentioned by Klink, Boon and Schlusmans (2007). For this reason, universities must try to meet these demands by re-functionalizing the engineering disciplines, leaving behind their traditional program model with specialized technical training (Damián, 2018; Capote, Rizo & Bravo, 2016; ASME, 2011;) and by making the curricular adjustments that guarantee a comprehensive profile of future engineers (Dorador, 2014; Rascón, 2012; Covarrubias, 1998). Various national and international studies make it clear that the field of professional performance of the engineer has changed given the great challenges humanity faces, to which they will have to find viable solutions from the scientific and technological field and with a great sense of social responsibility (UNESCO, 2010, Moreno, 2007; Restrepo, 2007).Therefore, it is necessary for the training of future engineers to take into account the duality of their professional area (design engineers-management engineers), that is, it must be ensured that at the end of their university training, these professionals have the

knowledge, skills and abilities that allow them to move professionally in both areas (Álvarez, 2014; ASME, 2011; Smerdon, 2000).

Groups of specialists and public and private associations of engineering areas have reached a consensus on the three components that should be included in the curriculum of this type of professional: Educational (exact sciences), specific education (engineering sciences) and complementary education (economic, social sciences and humanities) in order to meet the new requirements of the working world and its current form of organization (UNESCO, 2010; Moreno, 2007; ACOFI, 2007). In view of the above, universities are beginning to include in their curriculum, in a specific and transversal way, diverse topics of the administrative economic area. However, according to the results obtained in this work, it can be stated and concluded that it is a challenge to incorporate this type of topics in the engineering curriculum for both students and teachers. For the students, it is contradictory because they are not aware of the benefits and contribution to their professional training, which gives rise to an apathetic or indifferent attitude towards these courses. As for teachers, they are not prepared to address the contents with a focus on engineering and they do so using the same strategies and didactic resources they use with students in the area of administration or business, creating a gap between the objectives pursued by these subjects and the willingness of students to learn.

To overcome this challenge it is necessary for universities and engineering associations to take action by informing students of the advantages and benefits of studying economic-administrative subjects, and for teachers to apply teaching strategies aimed at engineering students to modify their performances about these courses and obtain a favorable opinion, considering them as an added value to the future engineers (Williams, 2004). Based on the results obtained by the actions undertaken in the teaching-learning process with engineering students described in this study, it is concluded that the above challenges can be overcome if there is awareness of the fact that the public universities must assume a leading role in the training of new generations of engineers with a multipurpose and multidisciplinary training

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that goes beyond the technical training, that is, a socio-technical training (Sáez, 2004; Correia & Bozutti, 2017).

Prospectively, it can be mentioned that the results of this work generated knowledge that contributes to an emergent line in the educational research, since it is acknowledged that little research has been made about the situation and the environment that prevails in the engineering students' classrooms during the teaching-learning process when developing administrative-economic topics. There is also very scarce research on the impact of cross-cutting subjects in the curriculum of engineering programs on the field of professional performance of engineers, indicating plenty of opportunities in order to generate knowledge on this subject through different lines of research.

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