v. 3, n. 40, 2023

International Journal of Human Sciences Research

ENGINEERING CURRICULUM, CURRICULAR ADJUSTMENT IN THE BASIC SCIENCES

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Abstract: The organization of the learning of the training programs in the field of engineering consists of the curricular design in correspondence with the proposed professional profile, in which the learning results that are intended to be achieved by levels are determined, establishing a number of hours. (credits) in teaching activities, links with society and pre-professional practices. In Ecuador, the Council of Higher Education is the body that regulates degree training, which in the case of engineering, has presented variants from the years 2013-2017 to the present date (2023), determining changes in the total numbers. of hours and subjects that together can have a duration between 8 to 10 academic periods, this change in configuration has led most universities to establish training at the minimum level, that is, 8 academic periods, which represent 5760 hours in total, with a number of 40 subjects, these curricular adjustments were applied to all subjects, determining a new curricular organization. The study presented corresponds to a descriptive analysis to identify the changes between the curricular designs of engineering majors since the application of the 2017 academic regime regulations with the implementation of the curricular adjustments made and their results in terms of its implementation. Likewise, how this change represented an opportunity to create the Center for Basic Sciences at ``Universidad Politécnica del Estado de Carchi``, in 2020, non-existent at that time. This innovation process is presented as a preliminary scope of several other investigations that are being developed to determine the level of impact of curricular adjustments in undergraduate training in the field of engineering.

Keywords: Curriculum; curricular adjustment, engineering; basic sciences.

INTRODUCTION

In Ecuador, the governing body of Higher Education, "Consejo de Educación Superior – CES", is the body that issues the guidelines that regulate universities with the issuance of laws, regulations and other standards, which direct training programs. both undergraduate and postgraduate, which must meet all the requirements both for new offerings and to continue, modify and innovate the existing one. The Academic Regime Regulations 2013 (Repealed in 2019), in its Article 14, determined the number of subjects, courses or their equivalents per career in higher technical, higher technological education and equivalents; and, undergraduate, in which the engineering training courses corresponded to a maximum number of 60 subjects, as shown in table N.1.

TRAINING LEVELS		MAXIMUM NUMBER OF SUBJECTS
ADVANCED TECHNICIAN		24
HIGHER TECHNOLOGICAL		30
THIRD GRADE LEVEL	**ENGINEERING**, ARCHITECTURE, DENTISTRY AND VETERINARY MEDICINE	**60**
	HUMAN MEDICINE	72

Table 1: Distribution of the number of technological training and degree subjects.

Source: Academic Regime Regulations – CES (2013-repealed)

In the same article it was detailed that:

> "the subjects, courses or their equivalents in face-to-face courses will be distributed sequentially and intensively throughout the academic periods in days of up to 6 hours a day for the teaching component, with at least two subjects, courses or similar." per ordinary academic period...No teacher may teach more than three different subjects, courses or their equivalents, simultaneously in an ordinary academic period, regardless of the number of parallels that the IES assigns to

> him or her." (RRA-CES, 2014). The duration of the degree courses, according to Article 17 (RRA-CES, 2014) in literal b. It referred to: "Engineering, Architecture and courses in Basic Sciences, with a requirement of 8,000 hours, with a duration of ten ordinary academic periods…"

The reform of the RRA, (CES, 2020. Current) in its Article 18, indicates the duration of third-level courses, whose planning would be carried out based on the following organization:

For the application of the reform to the academic regime regulations, deadlines were established for all universities, which were called "curriculum adjustments" that could be substantive and non-substantive (2020), under a methodological guide that requested details of the changes to be applied. This process of curricular adjustment for UPEC was a challenge in general, and even more so when it came to engineering, which in this case there are four: Food; Computing; Logistics and Transportation; Agriculture.

METHODOLOGY

The study presented corresponds to a case study (CS), a research methodology that is used to understand a particular case. The focus is on the uniqueness of the case. "The case is a limited system (bounded system), where the researcher must strive to delimit it well" (Stake, cited by Estevez, 2012). The greater the specificity, the easier it is to carry out the CE, it can be qualitative or quantitative; This study responds to a mixed approach, whose analysis is descriptive to identify the changes present between the curricular designs of engineering careers from the application of the 2017 academic regime regulation, until the 2020 reform with the implementation of the curricular adjustments made and their results in terms of the curricular design of each career, in a more specific and delimited way to the subjects that could or could not be called the common core.

The matrix technique was applied for data analysis, which made it possible to compare and determine similarity, decrease or increase in the curricular contents, expected learning results, number of hours and number of subjects that could be from the Basic Sciences. This work constitutes the first step of the formative research project "Analysis of learning results under international standards of students of the Center for Basic Sciences of engineering careers at UPEC" (2021).

RESULTS AND DISCUSSION

The University as a dynamic structure of society in the age of knowledge must demonstrate a high sense of relevance, even more so if it is located in a country seeking development. Therefore, both undergraduate and postgraduate engineering training must emphasize its social role as a fundamental characteristic since its creation. This vision must be closely consolidated with the company, the industry and the development plans of the nations, such as the most current trends in vocational training. Consequently, the curricular design of academic engineering programs must respond to the criterion of relevance, considering local, regional and global trends. Being an engineer means being an "ingenious", "innovative", "creative" professional par excellence, who combines science and technology at the service of the permanent improvement of industrial processes, manufacturing, and the optimization of resources. This professional approach is strengthened by considering the principles of sustainability, with an ethical sense of social responsibility. The reflection focuses on improving the quality of the academic program, to make engineering a pillar of innovation and the search for concrete solutions in harmonious and permanent evolution with current and future

		Duration in Pao (Does not include boarding school rotary in health areas)		Total cry (does not include rotary boarding school in health areas)		Total credits (no Includes boarding school rotary in areas of Health)		Number of courses or subjects Suggested	
		Mín.	Máx.	Mín.	Máx.	Mín.	Máx.	Mín.	Máx.
Third level Technical• Technologic al	Advanced technician	2	4	1 440	2 880	30	60	8	24
	Technological Superior	4	5	2 880	3 600	60	75	18	30
	Technological Superior academic	6	7	4 320	5 040	90	105	30	42
Third level of degree	Bachelor and Titles Professionals	8	10	5 760	7 200	120	150	40	60
	Veterinary	9	10	6 480	7 200	135	150	45	60

Table 2. Duration of third-level courses for the training of engineers.

Source: Reformed Academic Regime Regulations. (CES, 2020)

Reformed Academic Regime 2013				REGULATION OF REFORMIC REGIME 2020			
TITLE	N. de Hours	N. de subjects	N. of Periods	TITLE	Number of HOURS	Number of Subjects	N. of Periods
ENGINEERING	8000	60	I don't know determined	Bachelor's degree, OTRAS PROFESSIONS	minimum of 570 maximum 7200	between 40 and 60	From 8 to 10

Table 3. Comparison of Academic Regime Regulations 2013 to 2020 regarding engineering training.

Source: Comparative matrix based on the RRA.

ENGINEERING	FOOD	LOGISTICS AND TRANS-PORTATION	COM-PUTING	AGRI-CULTU-RAL	HOURS[1]			MINIMUM CONTENTS
SUBJECT	LEVEL	LEVEL	LEVEL	LEVEL	CD	AP	AA	
DIFERENTIAL CALCULUS	1	1	2	1	48	0	96	Functions/Limits/ DerivativesDerived applications
INTEGRAL CALCULUS	2	2	3	2	48	0	96	Introduction to integrals/ Indefinite/definite integralsApplications of integrals
PHYSICAL	1	2	1	1	40	8	96	Kinematics and description of movement/ Force and movement/ Work and Energy/ Static Balance

1. According to the Academic Regime Regulations, teaching activities are divided into three: CD: in contact with the teacher; AP: experiential practical learning and AA: Autonomous learning.

DESCRIPTIVE STATISTICS	**3**	**5**	**3**	**4**	**48**	**0**	**96**	**Introduction to statistics and data analysis/ Probabilities/Random variables/probability distributions, expectation and mathematical variance/Discrete and continuous probability distributions**
DIFFERENTIAL EQUATIONS	**3**	**3**	**4**	**3**	**64**	**0**	**80**	**First-order differential equations/Higher-order linear differential equations/Linear systems in differential equations/ The Laplace transform**
CHEMISTRY	**1**				**40**	**8**	**96**	**Kinematics and description of movement/ Force and movement/ Work and Energy/ Static Balance**
GENERAL BIOLOGY	**1**	**1**			**32**	**16**	**96**	**Biology as a science and its main branches / The cell / Metabolism / Post-harvest Conservation and Environmental Education.**
FUNDAMENTALS OF GEOMETRY AND TRIGONOMETRY		**1**			**32**	**0**	**40**	**Proportionality/ Triangles/ Circles/ Trigonometric functions/ Trigonometric identities.**
GEOMETRY AND TRIGONOMETRY			**1**		**32**	**0**	**40**	**Rectangular coordinate system and trigonometric functions/ Angular measurement systems/ Trigonometric identities and equations/ The straight line.**
INFERENTIAL STATISTICS	**4**	**1**	**4**		**32**	**0**	**64**	**Estimation / Hypothesis testing / Goodness of fit / Linear regression / One-factor experiments.**
LINEAR ALGEBRA	**1**	**2**	**2**		**48**	**0**	**96**	**Systems of linear equations / Vector spaces and subspaces / Linear transformations / Internal products / Values and vectors.**
APPLIED MATHEMATICS		**4**			**40**	**8**	**96**	**Fundamentals of financial mathematics and simple interest/ Compound interest and annuities/ Debt amortization and capital accumulation systems/ Comparison of investment alternatives**
APPLIED MATHEMATICS			**1**		**48**	**0**	**96**	**Boolean algebra / The field of real numbersAlgebraic expressions and factoring / Ratios and proportions**
DISCRETE MATHEMATICS			**2**		**32**	**0**	**40**	**Introduction to discrete mathematics/graphs Trees/Automata**

NUMERICAL METHODS		**4**		**16**	**16**	**40**	**Introduction to numerical analysis/ System of linear equations/ Numerical differentiation and integration/ Numerical differential equations**
INORGANIC CHEMISTRY			**1**	**32**	**0**	**40**	**Chemical solutions and nomenclature/ Chemical kinetics/ Instrumental chemistry/ Acids, bases and salts.**
ORGANIC CHEMISTRY	**2**		**2**	**32**	**0**	**40**	**Organic compounds: atomic and molecular structure, polarity and electronegativity / Alkanes, Alkenes and Alkynes / Aromatics and polycyclics Alcohols and Ethers Aldehydes and ketones / Carboxylic acids and esters, Amines and amides**
APPLIED PHYSIC	**2**	**2**		**32**	**16**	**96**	**Thermometry and heat propagation/ Thermodynamics. Electric charge and electric field/Electric current and resistance.**

Table 4. Analysis of the Basic Sciences subjects in the Engineering Degrees of the UPEC

Source: Curriculum analysis extracted from the meshes of each of the UPEC Engineering majors.

1.WIDE FIELD	2. SPECIFIC FIELD	3. DETAILED FIELD	4. CAREER	5. TITLE
06 Information and communication technologies (ICT	1 Information and communication technologies (ICT)	1. Use of computers	A. Computing	01. Computer Engineer
07 Engineering, industry and construction	2. Industry and production	1. Food Processing	B. Food	01. Food Engineer
08 Agriculture, forestry, fishing and veterinary	1. Agriculture	1. Agricultural and livestock production	B. Agriculture	01. Agricultural Engineer
05. Natural sciences, mathematics and statistics	4. Mathematics and statistics	81. Logistics and transportation transportation	A. Logistics and transportation	01. Logistics and Transportation Engineer

Table 5. Detail of the coding of the engineering careers of the undergraduate academic offer.

Source: Comparative table taken from the Annex to the Title Harmonization Regulations in force in Ecuador (2021)

trends (Sánchez, Oña, Garzón, 2017), the relevance of engineering training is such for development that the proposal for curricular adjustments must respond to those needs.

In Ecuador, the Council of Higher Education, placed, in the case of engineering, variants from the years 2013-2017 to the year 2020, period of curricular adjustments, determined changes in the total number of hours and subjects that as a whole can have a duration between 8 to 10 academic periods, this change in configuration led most universities to establish training at the minimum level, that is, 8 academic periods, which represent 5760 hours in total, with a number of 40 subjects, these curricular adjustments were applied to all subjects, determining a new curricular organization that is represented in Table 3, comparative matrix of the regulations and their respective reforms.

When applying the adjustments in terms of the number of periods, UPEC opted for nine ordinary academic periods (9 semesters), likewise, to adjust the curriculum and not prolong the time of students' graduation, extraordinary academic periods were applied, with a intensive time until completing the number of hours established in the curriculum.

This adjustment led to the analysis of the engineering curricula; with respect to the basic sciences, scattered subjects were found that were not related to the same designations present in each engineering, likewise, subjects that were not included in all majors, and repeated subjects. for example: Fundamentals of Geometry and Trigonometry in Logistics and Transportation; Geometry and Trigonometry, in Computing, in Food and Agriculture were not present. The subjects of Inferential Statistics and Linear Algebra were not included in Agriculture. Similarly, the subjects of Chemistry and Biology were only found in Food, then subjects such as Inorganic Chemistry only appeared in Agriculture and Organic Chemistry in both majors.

This comparative analysis can be seen in Table 4, where the engineering degrees offered at UPEC are presented with the subjects corresponding to Basic Sciences; level at which they are presented and number of hours that appear in the curricular designs approved by the CES (governing body of Higher Education in Ecuador), along with the minimum contents.

Another aspect of the analysis corresponded to the review of the Regulation for the Harmonization of the Nomenclature of professional titles and academic degrees conferred by higher education institutions in Ecuador (CES, 2021), which aims to establish the rules to harmonize the nomenclature of titles. professionals and academic degrees granted by higher education institutions (IES), with the following purposes: a) Facilitate the national and international mobility of students and professionals; b) Articulate the higher education system of Ecuador with other higher education systems at an international level; and, c) Generate comparative statistics in higher education. (RAT, Arts. 1 and 3; 2021).

Harmonization is the process by which two (2) or more similar professional titles, which differ in their name, are standardized through the application of a generic nomenclature. (RAT, Art. 4-b; 2021). Regarding the structure of the coding of professional titles and academic degrees, granted by the IES, it is organized into the following divisions for the third and fourth level: a) Code of the IES; b) Type of training, identified with two (2) digits, includes two (2) levels of academic training and corresponds to the most general classification of the coding; c) Broad field of knowledge, it includes ten (10) divisions and is identified with two (2) digits; d) Specific field of knowledge, identified with (RAT, Art. 21; 2021). Following the analysis from the

RAT (2021) in the general provisions, first, it states "as of the validity of this Regulation, the qualifications of the new careers and programs will be subject to the provisions of this Regulation"...

Regarding the Computer Science, Agriculture, and Livestock majors; Food and Transportation and Logistics, there is the following detail of the coding regarding the fields of knowledge: 1. Broad Field. 2. Specific Field. 3. Detailed Field. 4. Race. 5. Title, detailed information in table 5.

From the analysis carried out, it is clear that the Food, Agriculture, Logistics and Transportation, and Computing Careers are aligned with the Regulations for the Harmonization of Degrees in force in Ecuador; however, they belong to a different broad field and specific field, which although the degree is the engineer, it will be essential to review the curriculum against the indicated fields, especially to see the correspondence of the subjects that appear in the Center for Basic Sciences of the UPEC offer, which probably requires a more in-depth analysis to achieve the aforementioned harmonization and the professional profile that is desired to be achieved, according to the detailed field for each engineering.

BY WAY OF CONCLUSIONS

1. The matrix analyzes carried out, and the results obtained objectively, allow reflection on the importance of Basic Sciences in professional training in the field of engineering, as well as taking the contributions of Losada, Giraldo, Gasca and others (2015), It can be said that Basic Engineering Sciences (CBI) are recognized as a fundamental area of Applied Engineering. Due to the nature of engineering, training in these disciplines implies the connection and understanding of the real problems of the environment and the use of creativity to design effective solutions, requiring high levels of practical work from students both in teams and in groups. autonomously. Reason why the subjects must contemplate a logical sequence between their proposed minimum contents, relate to each other, towards the achievement of learning results that add to the professional profile.

2. Likewise, following the foundation and principles of the CDIO initiative (2013) "conceive, design, implement and operate", the training of engineers requires a significant percentage of training in Basic Sciences: mathematics, physics, biology, chemistry, statistics, which constitute the subjects that will allow future professionals to deepen the skills to "conceive and design", in the same way that they contribute to the development of inductive, deductive, convergent, divergent and creative thinking to delve into the problems and needs of the environment, as well as to propose creative and innovative, sustainable and relevant solutions, which will later be evidenced in the competencies related to "operate and implement."

3. These fundamentals must be taken into account when establishing curricular designs, and even more so the micro curricular, which can be differentiated in the degree of depth according to the broad field and the specific field of each branch of engineering, however there are concepts basics and generic competencies that cannot be avoided, more than necessary reasons to strengthen the Center for Basic Sciences, which at the same time promotes teacher training and updating towards the innovation of its practices and methodological strategies both in its teaching activities and in the

of experimental practice in laboratories.

4. The curricular adjustment and its consequent reduction of hours, subjects and academic periods, provided by the regulations in force in Ecuador, must lead to deep reflection and innovation in the careful selection of the knowledge required for the training of engineers, in what which refers to the Basic Sciences, as the conceptual basis towards the analysis of problems and search for creative and innovative solutions that promote the sustainable development that our peoples, nationalities and societies in general require so much, and that promote development accompanied by a planetary ethical sense.

5. The public policy of the Higher Education System in Ecuador must be aligned with the need to promote regional and international teacher and student mobility (CRES, 2008 and 2018), therefore, it is urgent to apply the recommendations that the different associations of engineers (ACOFI; ASIBEI), have proposed, in an emerging manner, standardization in duration times and credit equivalences.

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