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Artículos científicos

Evaluación curricular de la ingeniería en Computación de una universidad mexicana desde la percepción de sus egresados

Curricular Assessment of Computer Engineering from a Mexican University from the Perception of its Graduates

Avaliação curricular de Engenharia da Computação de uma universidade mexicana na percepção de seus graduados

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Resumen

Este trabajo tuvo como finalidad evaluar el currículo de la ingeniería en Computación de una universidad mexicana. Desde la perspectiva de sus egresados, se respondieron planteamientos relacionados con el cumplimiento de los objetivos del currículo, el nivel de satisfacción académica y la identificación de fortalezas y debilidades de la carrera.

La evaluación se llevó a cabo mediante un enfoque mixto. Para ello, se aplicó el modelo CIPP de Stufflebeam y Shinkfield (1987/2011), cuyo nombre responde a las cuatro etapas que lo integran: contexto, entrada, proceso y producto. Debido al propósito de la investigación, la evaluación se centró específicamente en la etapa de producto. La recolección de datos contempló la revisión del documento institucional en donde figuran los objetivos del currículo, la aplicación de dos cuestionarios a 63 egresados y una entrevista a un grupo focal integrado por 13 participantes. En el análisis de datos, a partir del documento institucional, se efectuó un análisis de contenido; a partir de la información obtenida de los cuestionarios, se concretó un análisis estadístico descriptivo y un análisis secuencial de discurso; a partir de los datos recabados en la entrevista con el grupo focal, se hizo también un análisis secuencial de discurso. Acerca de los resultados, se demostró que existe correspondencia entre los logros de la ingeniería en Computación y los objetivos enlistados en el currículo. Además, todos los egresados están siendo preparados con la mayoría de los conocimientos propios de un profesional de esta carrera. Sin embargo, en lo que respecta a las habilidades y destrezas, se está preparando adecuadamente solo a los egresados de la orientación en Software de Sistemas, y no a los de la orientación en Sistemas Digitales, ya que no existe correspondencia entre el perfil de egreso logrado por este y lo establecido en el currículo. Además, se demostró que los egresados están desarrollando actitudes y valores descritos por el currículo. Con relación a la satisfacción académica, los egresados expresaron haber tenido una buena experiencia cursando la carrera. Por último, se identificaron como fortalezas de la carrera el diseño de la malla curricular y las prácticas profesionales, mientras que las debilidades se vincularon con aspectos relacionados con la planta docente, los equipos y la infraestructura.

Palabras clave: calidad en la educación, CIPP, currículo, egresados, evaluación.

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Abstract

The purpose of this work was to evaluate the Computer Engineering curriculum of a mexican university. From the perspective of its graduates, proposals related to the fulfillment of the objectives of the curriculum were answered; the level of academic satisfaction; and identifying career strengths and weaknesses.

The evaluation was carried out using a mixed approach. For this, the CIPP model of Stufflebeam and Shinkfield (1987/2011) was applied, which its name responds to the four stages that integrates it: context, input, process and product. It should be noted that, for the purpose of the investigation, the evaluation focused specifically on the product stage. The data collection included the revision of the institutional document containing the objectives of the curriculum; the application of two questionnaires to 63 graduates; and, in addition, an interview with a focus group of 13 participants. In data analysis; based on the institutional document, a content analysis was made; based on the information obtained from the questionnaires, a descriptive statistical analysis and a sequential discourse analysis were made; from the data collected in the interview with the focus group, a sequential discourse analysis was also made.

About the results, the most important finding to note is that it was shown that there is a correspondence between the achievements of Computer Engineering and the objectives listed in the curriculum. In addition, that all graduates are being prepared with most of the knowledge of a professional in this career. However, when it comes to skills and abilities, graduates of Systems Software orientation are being adequately prepared; In the Digital Systems orientation, this does not happen since there is no correspondence between the graduation profile achieved by the graduates and what is established in the curriculum. Furthermore, it was shown that graduates are developing attitudes and values described in the curriculum. Regarding academic satisfaction, the graduates expressed having had a good experience studying the degree. Finally, they were identified; as career strengths, the design of the curricular mesh and professional practices; such as weaknesses, aspects related to the teaching staff and equipment and infrastructure.

Keywords: quality in education, curriculum, CIPP, graduates, evaluation.

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Resumo

O objetivo deste trabalho foi avaliar o currículo de Engenharia da Computação de uma universidade mexicana. Na perspectiva de seus egressos, foram atendidas propostas relacionadas ao cumprimento dos objetivos do currículo, ao nível de satisfação acadêmica e à identificação de pontos fortes e fracos da carreira.

A avaliação foi realizada por meio de uma abordagem mista. Para isso, foi aplicado o modelo CIPP de Stufflebeam e Shinkfield (1987/2011), cujo nome responde às quatro etapas que o compõem: contexto, entrada, processo e produto. Devido ao objetivo da pesquisa, a avaliação se concentrou especificamente na etapa do produto. A coleta de dados incluiu a revisão do documento institucional que contém os objetivos do currículo, a aplicação de dois questionários a 63 egressos e uma entrevista com um grupo focal composto por 13 participantes. Na análise dos dados, com base no documento institucional, foi realizada uma análise de conteúdo; A partir das informações obtidas nos questionários, foi realizada uma análise estatística descritiva e uma análise sequencial do discurso; A partir dos dados coletados na entrevista com o grupo focal, também foi feita uma análise sequencial do discurso.

Em relação aos resultados, evidenciou-se que existe uma correspondência entre as realizações da Engenharia de Computação e os objetivos elencados no currículo. Além disso, todos os egressos estão sendo preparados com a maior parte do conhecimento de um profissional dessa carreira. Porém, no que se refere às competências e habilidades, apenas os graduados da orientação de Software de Sistemas estão sendo adequadamente preparados, e não os da orientação de Sistemas Digitais, uma vez que não há correspondência entre o perfil do graduado alcançados por isso e pelo que está estabelecido no currículo. Além disso, foi demonstrado que os egressos estão desenvolvendo atitudes e valores descritos no currículo. Em relação à satisfação acadêmica, os egressos expressaram ter tido uma boa experiência no curso de graduação. Por fim, o desenho do currículo e as práticas profissionais foram identificados como pontos fortes da carreira, enquanto as fragilidades foram vinculadas a aspectos relacionados ao corpo docente, equipamentos e infraestrutura.

Palavras-chave: qualidade em educação, CIPP, currículo, graduados, avaliação.

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Introduction

The institution of public education hosting this research has a history of more than 200 years and, currently, it is one of the most prestigious study houses in Mexico (Universidad de Guadalajara, 2018a). This university stands out for the training of high-level human resources and for the production of scientific and technological knowledge, as well as for its academic community, one of the most important in the country (University of Guadalajara, 2018b) .In addition, it is made up of a network that includes six thematic university centers, nine regional university centers, a virtual education system and an upper secondary education system (Universidad de Guadalajara, 2018c).

As part of this network, in 1994 a regional university center (hereinafter CUR) was founded with the aim of generating educational spaces in the state of Jalisco, Mexico, to meet the growing demand of the city and other neighboring entities, and to serve as a model of higher education that promotes the social and cultural development of the region (Centro Universitario de la Costa, 2018a).

Since its inception, the CUR has had a progressive growth in all aspects. With regard to the educational offer, in 2003 the Computer Engineering (hereinafter INCO) was created, which was incorporated into an offer that currently has 19 professional careers, 7 masters, 3 doctorates and 28 diplomas (Centro Universitario de la Costa, 2018b).

Establishment of the problem

Quality is a term with many meanings. However, for Blanco (1996), when it is related to education, it is possible to use it in a descriptive or normative way. This author describes that the first is generated when "a student, a teacher, a center or a system meet a certain number of qualities or defining characteristics", while the second refers to the "degree of excellence or relative value" (p. twenty-one).

On the other hand, Braslavsky (2006) affirms that education can be considered of quality when it allows people to learn what they need at the right time in their lives and in society. To achieve this, the public education institution, in its 2014-2030 institutional development plan, indicates that it is vitally important to improve curricula based on diagnoses and national and international trends (Universidad de Guadalajara, 2014). For its part, the CUR - in its center development plan: vision 2030 - shows that in order to raise its indicators it is necessary to

evaluate the relevance of the curricula in relation to national and international needs and trends, according to the area theme of each of them (Centro Universitario de la Costa, 2014).

Consequently, in order to determine if students are learning what is necessary at the right time, diagnoses are required that show the relevance of each of the professional careers offered. For this, it is essential to start from evaluations that allow determining the current status of each of these curricula.

The topic

The subject of this research is curricular evaluation. For this type of study there are different models, and despite the fact that there is no consensus among the authors on their classification, six possible categories are distinguished: 1) results models, 2) explanatory models of the process, 3) economic models, 4) actor models, 5) program theory models, and 6) systematic models (Hansen, 2005).

According to Gómez and Mora (2011), when the curricular evaluation is linked to the improvement of the quality of education is a subject of debate, and this has happened since the end of the 20th century and the beginning of the 21st. However, as they point out, beyond the discrepancies, the curricular evaluation is a method that has proven to be effective and efficient to know strengths and areas of opportunity.

Before continuing with the next point of this work, it is important to mention that the curriculum "is an attempt to communicate the essential principles and features of an educational purpose, in such a way that it remains open to critical discussion and can be effectively translated into practice. "(Stenhouse, 1984/2010, p. 29). Until the 19th century, this was known as the curriculum or educational program (Valenzuela and Juárez, 2011). For the purposes pursued in this research, and henceforth, it was decided to refer to the curriculum as such, with some exceptions in which it will be called an educational plan or program; this last provision in attention to the way it is approached in the literature consulted for this work.

Research Problem

As stipulated in the opinion that endorses the creation of INCO, the degree was conceived in order to train professionals oriented towards computer systems hardware and software; professionals with basic knowledge to be applied in different areas such as industry,

business, education and telecommunications, as well as in the multiple branches of engineering to conceive the most varied applications.

In this same documentation, in addition to the study plan, the details about the creation of INCO (that is, justification, objectives, graduation profile, labor field, modality, among others) are also disclosed. However, and despite the length of the opinion, it is not stipulated in what way the curriculum itself will be evaluated. In this regard, Álvarez (2012) warns that, at present, the curriculum should be in a permanent review process to try to respond to the changing needs of a dynamic society.

Since 2000, the CUR has turned to external bodies to evaluate and formally acknowledge the quality of its educational programs. In Mexico, this type of support is granted by the Council for the Accreditation of Higher Education [Copaes] (2018), the highest authority endorsed by the federal government, through the Ministry of Public Education (SEP).

Despite the fact that INCO has already undergone evaluations of this type - or accreditations, as they are commonly known - CUR authorities agree that a process of this nature does not provide the qualitative information that allows identifying the level of correspondence between the career curriculum and its objectives, and does not provide information capable of guiding decision-making with a view to improving it in this regard (AE López, personal communication, October 7, 2017). It is also noted that the accreditations are mainly focused on students, teachers, managers and the facilities themselves, leaving graduates behind in the process. As a result, both the level of personal satisfaction that the latter have with respect to their academic training and the strengths and areas of opportunity of the career in the labor field are unknown (L. R. Salazar, personal communication, October 8, 2017).

Essentially, due to the situation described so far, it became clear that INCO is unknown a) the level of correspondence between the curriculum and its objectives, b) the level of academic satisfaction of the graduates, and c) the strengths and weaknesses of the career.

Background and rationale

According to the INCO creation opinion, the professional in this career accounts for the demands and requirements of areas such as industry, business, education, telecommunications and different branches of engineering, which are manifested in the form of Needs related to computational tools, where the main area of performance is the basic software (primary computer programs) and the digital subsystems of networks, telecommunications and

computing, as well as modern techniques for creating and adapting large computer systems . In addition, it is established that the INCO graduate must have the skills to:

1. Design, build and operate digital systems applicable to computer technology.
2. Design and write programming systems with a high degree of technical difficulty, compilers, operating systems and telecommunication networks, in order to integrate medium and large computer systems.
3. Develop systems and find creative and innovative solutions to solve problems related to the reliable administration of resources, which allows you to increase efficiency in the operation of production systems and streamline the control and management of all types of information.
4.Use experimental, analytical and heuristic techniques to solve problems related to hardware, software and their applications.
5. Apply relevant knowledge in the identification and systematic solution of practical problems in their area of expertise.
6. Analyze, judge and take positions regarding the role of computers in the progress of science, technology and in the life of the human being.

To verify that INCO is complying with what is stipulated in its curriculum, as mentioned, it has undergone external evaluations by what are known in Mexico as accrediting bodies. To date, INCO has been evaluated on two occasions, specifically by the National Council for Accreditation in Informatics and Computing (Conaic) (A. E. López, personal communication, October 7, 2017). It is worth mentioning that said body is the body recognized by Copaes to evaluate and accredit educational programs related to computing and computing, at the upper secondary level, higher technical university and higher (Consejo Nacional de Acreditación en Informática y Computación, 2018).

Regarding internal evaluations, INCO has not been part of this type of process or any other type of study or investigation with a similar purpose. Such a situation is not by chance because the CUR lacks a culture of systematic internal evaluation that focuses on improving curricula (A. E. López, personal communication, October 7, 2017).

Despite the fact that a curricular evaluation is very broad and involves too many variables, the CIPP model of Stufflebeam and Shinkfield (1987/2011) was perfectly suited to carry out this research. This model allows a curriculum to be partially or totally evaluated, that is, a single stage can be used or two or more can be combined. For the purposes pursued in

research, only the last stage - the product stage - was used, since it is the one that makes it possible to assess the level of correspondence between the career curriculum and its objectives, estimate the level of academic satisfaction of graduates and Identify career strengths and weaknesses.

Purpose of the study

The purpose of this research was to evaluate the curriculum of the Computer Engineering career of a Mexican university to make a judgment regarding the fulfillment of the objectives set out in its curriculum.

Research questions

1. Is there a correspondence between the INCO curriculum and the objectives established in the institutional document that supports the creation of the curriculum?
2. What is the level of academic satisfaction of INCO graduates?
3. What are the strengths and weaknesses of INCO from the perspective of graduates?

Materials and method

Based on the purpose of the research, a mixed non-experimental approach was chosen; non-experimental because it allows observing a phenomenon (the curriculum) without intentionally altering the variables; and mixed because in this way it is possible to collect and analyze both qualitative and quantitative data essential to answer the research questions. (Hernández, Fernández y Baptista, 2014).

Participants

The population of this research was made up of 86 graduates, a figure that corresponds to the total sum of men and women, of legal age, who successfully completed INCO in the last six semesters (at the time of the study). The sample was made up of 63 students, a number that was calculated from the estimation of the proportion of the population, since this is a recurring technique when the population is known or finite, and when the sampling is to be probabilistic or random (Arias, 2012). To perform this calculation, given the conditions, and according to Del Cid, Méndez and Franco (2011), the most appropriate formula is the following:

$$n = \frac{Z^2\ P\ Q\ N}{E^2\ (N-1) + \ Z^2\ P\ Q}$$

As:

n = Sample

Z = Confidence level or chosen significance value (1.96)

P = Probability of success (0.05)

Q = Probability of failure (0.95)

N = Population (86)

E = Maximum permissible error (0.03)

With an expected confidence level (Z) of 95%, and with a maximum allowed error (E) of 3%, when substituting values, the formula is as follows:

$$n = \frac{(1.96)^2\ (0.05)\ (0.95)\ (86)}{(0.03)^2\ (86-1) + \ (1.96)^2\ (0.05)\ (0.95)} = \ 60.59$$

It is important to mention that although it is not part of the population as such, the opinion or document that supports the creation of the curriculum (hereinafter DACC) was of vital importance for the intended purpose, so it was considered a valuable source of written information and, therefore, as a participant. This document dates from March 29, 2003, according to CUR files. As mentioned, it specifies the details of the creation of INCO, such as the justification for its creation, its objectives, graduation profile, teacher training, institutional services, subjects to be studied, among others.

Instruments

Two questionnaires and a focus group were used to answer the research questions. The instruments and the procedure for their validation are described below:

Graduate profile questionnaire

The first of the instruments was called the graduation profile questionnaire (hereinafter CPE). This consists of 22 closed questions with different Likert-type response options. Questions 1 to 17 present five response options, namely: 1) not prepared, 2) poorly prepared, 3) undecided, 4) prepared and 5) very prepared. From questions 18 to 21 they present five other answer options: 1) not developed, 2) little developed, 3) undecided, 4) developed and 5) very developed. The final question (number 22) presents only two possible answers: 1) yes and 2)

no. At the end of all the questions, the participant has a blank space to explain the reason for their answer. The career has two orientations or specializations: 1) Systems Software and 2) Digital Systems. In this sense, it should be noted that there are four specific questions for orientation. From questions 10 to 13 are aimed at students with an orientation in Systems Software, and from 14 to 17 to those with an orientation in Digital Systems.

The CPE was designed to obtain information on knowledge, abilities, values and skills that graduates were able to acquire during their career. Based on the above, the structure or arrangement of the instrument corresponds to: 1) six questions focused on the knowledge obtained, 2) eleven questions (three general and eight particular: four for orientation) concerning the skills and abilities acquired, 3) four questions related to the values and attitudes developed, and 4) a final question whose objective is to gather the opinion of the graduates to find out if the career provides them with the necessary tools (knowledge, skills, values, skills and attitudes) to get a job. The latter based on the point of view of each of them after having applied for a job in a field related to the career.

Academic training questionnaire

The second instrument was called the academic training questionnaire (hereinafter CFA). This was divided into four blocks, with a total of 22 questions: 20 closed and two open. Both the first block (from questions 1 to 7) and the second (from questions 8 to 14) are evaluated in two stages. In the first instance, the coverage is evaluated and later the quality. Although this fragment of the evaluation is done in two stages, both present similar Likert-type response options: 1) minimal, 2) low, (3) fair, 4) good and 5) excellent.

In the third block (from questions 15 to 19) there are five Likert-type response options: 1) minimal, 2) low, 3) fair, 4) good and 5) excellent. Although this block may seem similar to the previous ones, there are two important differences: first, the evaluation is not done in two parts; secondly, at the end of each question the participant has a blank space to explain the reason for their answer.

The fourth and last block consists of three questions (20 to 22). The first two questions are open, and the question that ends this instrument is closed.

The design of the CFA makes it possible to inquire about the academic training experience of the graduates of the degree. Based on the above, the structure or arrangement of the instrument corresponds to: 1) seven questions focused on identifying how graduates evaluate

material, academic and administrative aspects; 2) seven questions focused on identifying how graduates evaluate particular aspects of curriculum design; 3) five questions focused on the particular aspects of teachers, and 4) two open questions whose objective is to collect suggestions for change to INCO with a view to improving the academic training of new generations. The latter from the point of view of each one of them as INCO graduates.

Validity and reliability of the instruments

To establish the reliability and validity of the CPE and the CFA, due to the similarity, the same procedure was followed in both. First, a content validation instrument was designed and applied and subsequently a pilot test was applied. The content validation instruments were called VCPE or validation of the graduation profile questionnaire and VCPE or validation of the academic training questionnaire. Such validation instruments were designed in order for experts in the area of teaching and computing to evaluate the relationship between the CPE and CFA questions with the purpose of the study and the research questions. It should be noted that the instruments included key elements, such as 1) criterion, 2) relevance and 3) observations or suggestions for each question.

The criterion was linked to different aspects. In the case of the CPE, with the keyword that is related to the first research question, and represents the knowledge, skills, values, skills and abilities that characterize the graduate of a profession based on the performance evidenced during their training process. In the case of the CFA, it was linked to the keyword that is related to the second research question, and represents particular aspects of the graduate's academic training.

The relevance consisted in assessing whether the content of the question was related to the purpose of the study and to the research question to which the instrument intended to answer. The last element, observations or suggestions, had the purpose of raising awareness of the elements that could be modified, eliminated or included in the CPE and the CFA.

In total, four experts participated in the validation of both instruments. All of them with experience in field research and academic training in areas such as technologies, computing, telecommunications and education. Individually and independently, the two questionnaires (CPE and CFA) and the two validation instruments (VCPE and VCFA) were delivered to the experts. Before they started filling out the VCPE and VCFA, they were asked to read them together with the CPE and the CFA to resolve any doubts.

For the pilot test, 11 graduates of the race participated. Both the CPE and the CFA were sent to them through Google. Once the pilot test was applied, to calculate the coefficient of reliability of the CPE and the CFA, the measures of coherence or internal consistency were used, specifically from Cronbach's alpha. According to Hernández et al. (2014), in addition to being one of the most used procedures, it allows calculating reliability from a single application of the measurement instrument, and is calculated based on the following formula:

$$\propto = \frac{K}{K-1}\left[1 - \frac{\sum V_i}{V_t}\right]$$

As:

$\propto$ = Cronbach's alpha

K = Number of items (questions or reagents)

V_i = Variance

V_t = Total Variance

With this formula we obtain results that go from zero to one; values closer to zero indicate low reliability; otherwise, those closest to one are indicative of high reliability (Hernández et al., 2014). To instantly calculate this value, the statistical analysis software SPSS (Statistical Package for the Social Science) was used. After entering the data into the program, the resulting reliability level for the CPE was 0.810, while for the CFA it was 0.903.

At the end of the validation process, both the CPE and the CFA received good reviews from the experts. It should be noted that minimal drafting changes were made; they were modified in terms of form without being necessary to touch basic aspects. In the specific case of the CFA, on the recommendation of the experts, one question was relocated and two others were eliminated as they were considered irrelevant to the study.

Discussion guide

The third instrument is called a discussion guide (hereinafter GD), and it was designed to be applied to a focus group made up of graduates. The structure of the GD includes 1) welcome, 2) purpose of the session, 3) procedure for conducting the focus group research technique, 4) questions, 5) farewell and 6) gratitude.

The questions contained in the GD are intended to identify the strengths and weaknesses of the career curriculum. These were formulated from three aspects: 1) the objectives established in the CIPP model (Stufflebeam and Shinkfield, 1987/2011), 2) the review of studies where the focus group technique has been implemented, and 3) the definition of strength and weakness.

Validity and reliability of the discussion guide

To establish the reliability and validity of the GD, the validation of constructs was used, in the first instance, to establish their relationship with the concepts to be measured, which made it possible to determine if the instrument would help, in this specific case, to respond to the third research question. In summary, and for this purpose, only two constructs were validated: strength and weakness.

During this stage, the support of four experts with experience in field research and academic training in areas such as research methods and education was requested. Together with them, a definition was constructed for each of the terms, remaining as follows: 1) the term strength refers to all the objectives achieved by the INCO curriculum, and that help to differentiate it from other educational programs or curricula of the same nature, and 2) the term weakness refers to all those human, material and technological resources that prevent the objectives set out in the INCO curriculum from being achieved.

In the second instance, content validation was used. In this sense, Bautista (2009) affirms that an instrument is valid as long as it has considered all the important aspects to be measured, for which an exhaustive review of the literature must first be carried out beforehand and, finally, a consultation with experts to propose the aspects to be measured.

Therefore, four experts with experience in academic training in the area of computing were used. They were given, individually and independently, the validation instrument for the discussion guide (VGD), in order to validate the items presented there. At the end of the entire process, the results obtained determined that these reagents were relevant to evaluate the strength and weakness constructs.

Process

Design

A mixed non-experimental approach was used to carry out the research. According to Hernández et al. (2014), in a non-experimental study the researcher observes the already existing situations (he cannot influence because the events have already taken place, as well as their effects). The mixed approach was used, as indicated by Creswell (2012), to be able to analyze both qualitative and quantitative data for a better understanding of the research problem.

This is understood in the sense that the INCO curriculum is an "existing situation", whose variables and effects have already taken place and have repercussions on the graduates. Then, identifying those effects and repercussions that the curriculum already had on the graduates is what made it possible to determine the correspondence that exists between the career curriculum and the established objectives. For its part, the mixed approach is what made it possible to gather and analyze the opinions of the graduates regarding their academic training. Likewise, based on this information, it was possible to identify INCO's strengths and weaknesses.

In short, the research was designed from a three-stage procedure. Table 1 shows these phases with each of the elements that were present in them, that is, the participants, the research techniques, the instruments and the research question to which they respond.

Tabla 1. Etapas para la evaluación del currículo de la INCO

Etapa	Participantes	Técnica(s) de investigación	Instrumento(s)	Pregunta de investigación
1	DACC y 63 egresados de la INCO	Análisis de contenido y cuestionario	Cuestionario (CPE)	Pregunta uno
2	63 egresados de la INCO	Cuestionario	Cuestionario (CFA)	Pregunta dos
3	13 egresados de la INCO	Grupo focal	Guía de discusión (GD)	Pregunta tres

Fuente: Elaboración propia

At this point, it is important to point out that the instruments, as in the pilot test, were administered via Google Forms, and the discussion with the focus group was carried out in person at the campus facilities. For the systematization of the data, the results obtained from the instruments were exported to Microsoft Excel. As for the results of the discussion, they were recorded and later also captured in Microsoft Excel for their categorization.

Data analysis

For the data analysis, exactly the same order was followed as in table 1. This phase was also divided into three stages, each of which follows the sequence in which the research questions were presented; that is, the data analysis was also divided into three stages. Next, for a better understanding of the data analysis process, the treatment given to each of the instruments in their respective stage is explained.

Stage 1. This stage was carried out in two stages: first the DACC was analyzed and then the CPE. It should be remembered that at this stage we sought to answer the first research question, which refers to the correspondence between the INCO curriculum and the objectives established in DACC.

The DACC, by its nature, was classified as an institutional document (Fernández, 2002). For this reason, a content analysis was first carried out, specifically of the descriptive type, which, according to López (2002), is essential when identifying the basic components of a document through a rigorous measurement process.

After the analysis of the DACC, a descriptive statistical analysis of the closed questions of the CPE was carried out in order to identify the development of knowledge, skills, abilities, attitudes and values of the graduates, starting from the mean, the mode and the standard deviation of each item. In this regard, Münch and Ángeles (2009/2011) confirm that descriptive statistics is a technique that allows organizing and summarizing quantitative data. They also point out that with this technique it is possible to individually analyze each question of an instrument in order to later analyze everything together. Finally, a content analysis of the why or the arguments of each of their responses to the closed questions was also carried out.

Stage 2. In the second stage, with the data collected from the CFA instrument, we sought to answer the second of the research questions, which refers to the level of academic satisfaction of INCO graduates. On this occasion, due to the similarity of the CFA with the CPE, the data received the same treatment. From the closed questions, a descriptive statistical analysis was carried out in order to identify the level of satisfaction of the graduates on material, academic and administrative aspects. A content analysis was also generated from the open questions, in the same way that it was done with the whys of each of the answers to the closed questions.

Stage 3. The last stage included the analysis of data collected from the discussion guide or DG used during the focus group session. The research question that was sought to be answered is the one that refers to the strengths and weaknesses of INCO. For this, as an

analytical technique, a sequential discourse analysis was carried out that, as established by Flick (2004), focuses on the memories, descriptions and / or formulations of the participants, and redirects them to the themes (strengths and weaknesses) of the analyzed context.

Results

Research question one

The first question refers to the correspondence between the INCO curriculum and the objectives established in the DACC. To answer it, a two-phase process was carried out. In the first, a content analysis of the DACC was carried out and, as a result of the analysis, three categories or dimensions were established based on the graduation profile of INCO students, namely: 1) knowledge, 2) abilities and skills, 3) attitudes and values. In the second phase, the data obtained from the descriptive analysis of the CPE items were recovered.

Next, in Table 2, the results of the descriptive statistical analysis of the CPE are presented. Data were broken down by item and items were grouped by dimension.

Tabla 2. Análisis estadístico del cuestionario perfil de egreso (CPE)

Dimensión	Ítem	Media	Moda	Desviación estándar
Conocimientos	1. Arquitectura de computadoras	3.70	4.00	0.96
	2. Redes	3.35	4.00	0.99
	3. Programación	3.56	4.00	1.07
	4. Tratamiento de la información (estructura de datos, estructura de archivos)	3.54	4.00	0.91
	5. Interacción hombre-máquina (gráficas por computadora, multimedia)	3.22	4.00	1.10
	6. Entorno social (comunicación oral y escrita, redacción, análisis contable, propiedad intelectual)	3.41	4.00	1.07
Habilidades y destrezas [generales]	7. Planeación, diseño, administración, implementación y producción de sistemas que permiten aumentar la eficiencia de operación de las organizaciones	3.16	4.00	1.11
	8. Uso de técnicas experimentales, analíticas e innovadoras para la solución de problemas (a través de *hardware* y *software*)	3.27	4.00	1.11
	9. Diseño e implementación de arquitectura de computadora y desarrollo del *software* de aplicación que le compete	3.48	4.00	1.06
Habilidades y destrezas [*Software* de Sistemas]	10. Diseño y desarrollo de sistemas de *software* de base (los sistemas de programación primordiales en una computadora)	3.48	4.00	0.92
	11. Habilidad para interactuar con subsistemas digitales y de telecomunicaciones (redes)	3.31	3.00	1.08
	12. Diseño e implementación de sistemas operativos	3.13	4.00	1.01
	13. Diseño y concepción de nuevos lenguajes de programación, así como construcción de compiladores (traductores)	2.63	3.00	1.19
Habilidades y destrezas [Sistemas Digitales]	14. Diseño, construcción, instalación, operación y mantenimiento a sistemas digitales e interfaces	3.09	4.00	1.22
	15. Diseño e implementación de herramientas de *software* necesarias para el manejo del *hardware*	2.73	3.00	1.27
	16. Concepción, diseño y construcción de hardware computacional que satisfaga definiciones de funcionabilidad y fines específicos	2.55	4.00	1.29

	17. Concepción, diseño y construcción de sistemas de transmisión y comunicación de información (redes)	2.82	2.00	1.08
Actitudes y valores	18. Responsabilidad, profesionalismo y búsqueda de la calidad	3.97	4.00	0.74
	19. Actitud de superación continua (especialmente en el área de computación)	4.00	4.00	0.92
	20. Disciplina, tenacidad y autoexigencia para alcanzar objetivos personales y profesionales	4.11	4.00	0.67
	21. Creatividad para diseñar y desarrollar sistemas que atiendan las necesidades propias del trabajo	3.75	4.00	0.95

Fuente: Elaboración propia

It is important to mention that the responses to the items were grouped into three groups: positive, neutral and negative. Scales 1 and 2 (not prepared / poorly prepared) were grouped as negative responses, while scales 4 and 5 (prepared / very prepared) were grouped as positive responses, as shown in Table 3.

Tabla 3. Porcentaje acumulado por tipo de respuesta para cada dimensión

Dimensión	***No preparado / Poco preparado***	***Indeciso***	***Preparado / Muy preparado***
Conocimientos	20	21	59
Habilidades y destrezas [generales]	24	24	52
Habilidades y destrezas [*Software* de Sistemas]	28	30	42
Habilidades y destrezas [Sistemas Digitales]	45	18	36
Actitudes y valores	7	12	81

Fuente: Elaboración propia

The "knowledge" dimension indicates that the graduate must have theoretical-practical mastery in areas such as computer architecture, networks, programming, information processing, human-machine interaction and the social environment. Here, the CPE yielded 59% positive responses, 20% negative, and 21% neutral. From these results, it was found that 1) the graduates are being prepared with respect to the theoretical-practical domain in the areas that are stipulated in the DACC, and 2) the areas to which mention is made are a) architecture of computers, b) networks, c) programming, d) information processing, e) human-machine interaction, and f) the social environment.

The dimension of "abilities and skills" is described in three aspects: general, particular of the Systems Software orientation, and particular of the Digital Systems orientation. Regarding the general abilities and skills, it is indicated that they should cover the planning, design, administration, implementation and production of systems; the use of experimental, analytical and innovative techniques for problem solving (through hardware and software); and the design and implementation of computer architecture and software development. For this dimension, the CPE yielded 52% positive, 24% negative and 24% neutral responses.

Based on the findings, it was found that INCO graduates are being prepared with respect to the abilities and skills of the career profile, as stipulated in the DACC. The skills and abilities referred to are: a) systems planning, design, administration, implementation and production, b) experimental, analytical and innovative techniques for problem solving, and c) design and implementation of computer architecture and software development.

In the Systems Software orientation, it is stated that graduates should develop in terms of the design and development of basic software systems; interaction with digital and telecommunications subsystems; the design and implementation of operating systems; and the design and conception of new programming languages, as well as the construction of translators. Here, the CPE returned 42% positive, 28% negative and 30% neutral responses. Based on these results, it was found that 1) graduates are being prepared with respect to the abilities and skills of the graduate profile with this orientation, as stipulated in the DACC; 2) the abilities and skills in which they are prepared are: a) the design and development of basic software systems, b) the interaction with digital and telecommunications subsystems, c) the design and implementation of operating systems; and 3) they are not being adequately prepared in terms of the design and conception of new programming languages, as well as in the construction of translators.

In the orientation in Digital Systems, it is indicated that graduates should develop in terms of design, construction, installation, operation and maintenance of digital systems and interfaces; the design and implementation of software tools necessary for managing the hardware; the conception, design and construction of computational hardware that is functional and for specific purposes; and the conception, design and construction of information transmission and communication systems. In this case, the CPE yielded a total of 45% negative, 36% positive and 18% neutral responses. From these results, it was found that 1) graduates of this career are not being prepared with respect to the abilities and skills of the graduation profile with this orientation, as stipulated in the DACC; 2) the abilities and skills in which they are not

prepared are: a) design and implementation of software tools necessary for the management of hardware, b) conception, design and construction of computational hardware that is functional and for specific purposes, and c) conception, design and construction of information transmission and communication systems. They are only being prepared in regards to design, construction, installation, operation and maintenance of digital systems and interfaces.

The dimension of "attitudes and values" indicates that the INCO graduate must develop attitudes and values such as responsibility, professionalism and the search for quality, continuous improvement, discipline, tenacity and self-demand to achieve personal and professional goals, as well as creativity. The results showed that 81% of the responses were positive. Based on these results, it was found that 1) graduates are developing attitudes and values of the INCO graduation profile, as stipulated in the DACC, and 2) the attitudes and values mentioned are a) responsibility, professionalism and the search for quality, b) continuous improvement, c) discipline, tenacity and self-demand, and d) creativity to design and develop systems.

Research question two

Through the academic training questionnaire or CFA, we sought to answer the second research question. From this question we sought to identify the level of academic satisfaction of INCO graduates. The evaluation that was made with this instrument considered various aspects that were grouped into three categories:

Category one: material, academic and administrative aspects

In this study, the graduates evaluated the coverage and quality of a) the physical facilities, b) the computer equipment, c) the specialized equipment for practices according to their orientation, d) the library service, e) the bibliographic collection, f) administrative services, and g) complementary services.

Category two: particular aspects of curriculum design

In this study, the coverage and quality of a) theoretical content, b) practical content, c) social content, d) professional practices, e) comprehensive training, f) academic tutoring, and g) mobility were evaluated. student.

Category three: particular aspects of teachers

In this, in general, a) domain of the topic or subject, b) didactic competences, c) the use of didactic materials, d) the use of information and communication technologies, and e) the availability outside the the classrooms.

Next, in Table 4, the result of the descriptive statistical analysis of the CFA is presented. The data is described by item and for each item there is a column for coverage and another for quality, in addition, the items are grouped by category. The last category, about the particular aspects of teachers, was not evaluated based on coverage and quality, but taking into account the experience of teachers, their didactic skills, the use of diversified and current didactic materials, the use of technologies and their availability outside the classrooms and class hours.

Tabla 4. Análisis estadístico del cuestionario formación académica (CFA)

		Cobertura			Calidad		
Aspecto	**Ítem**	**Media**	**Moda**	**Desviación estándar**	**Media**	**Moda**	**Desviación estándar**
Materiales, académicos y administrativos	1. Instalaciones físicas (laboratorios, salones de clase, biblioteca, auditorios)	3.65	4	0.77	3.57	4.00	0.73
	2. Equipo de cómputo	3.78	4	0.75	3.49	4.00	0.88
	3. Equipo especializado para prácticas según tu orientación o especialidad (sistemas digitales o *software* de sistemas)	3.03	3	0.97	3.03	3.00	0.98
	4. Servicio de biblioteca (atención y disponibilidad del personal)	3.92	4	0.77	3.86	4.00	0.82
	5. Colección de libros de biblioteca (actualidad y disponibilidad)	3.62	4	0.97	3.60	4.00	0.99
	6. Servicios administrativos ofrecidos por la institución (coordinación de carrera, control escolar, servicio social, becas, otras unidades y directivos)	3.97	5	0.95	4.03	5.00	0.95
	7. Servicios complementarios (servicios médicos, cafetería, papelería, estacionamiento, seguridad, etc.)	3.52	4	0.98	3.46	3.00	0.98
Diseño curricular	8. Contenidos teóricos	3.62	4	0.89	3.49	3.00	0.95
	9. Contenidos prácticos	3.21	3	1.00	3.30	3.00	0.94
	10. Contenido social (materias del plan de estudios que responden a las necesidades que demanda el mundo laboral)	2.98	3	1.01	3.11	3.00	1.02
	11. Prácticas profesionales (empresas u opciones donde se pueden realizar las prácticas)	3.43	4	1.17	3.46	4.00	1.15
	12. Formación integral (eventos académicos, deportivos, culturales, etc.)	3.56	4	0.96	3.57	4.00	0.95
	13. Tutoría académica durante los estudios	3.24	3	1.03	3.32	3.00	1.03
	14. Movilidad estudiantil (oportunidades para cursar parte de la carrera en otra universidad, a nivel nacional o internacional)	3.32	3	0.91	3.35	4.00	0.92
Docentes	15. Dominio que tienen los profesores del tema o materia (experiencia)	3.41	3	0.99			
	16. Competencias didácticas de los profesores (recursos y estrategias empleados para enseñar; habilidad para dar clases)	3.38	4	0.92			
	17. Uso de materiales didácticos proporcionados por los profesores en clase	3.67	4	0.84			

	(textos impresos o digitales, videos, presentaciones con diapositivas, etc.)						
	18. Uso de tecnologías de la información y comunicación por parte de los profesores para impartir clases	3.78	4	0.81			
	19. Disponibilidad de los profesores fuera de las aulas y de los horarios de clase (asesorías)	3.56	3	1.12			

Fuente: Elaboración propia

In the same way as was done with the CPE, the responses were also grouped into three groups: positive, neutral, and negative. Scales 1 and 2 (minimal / low) were grouped as negative responses, while scales 4 and 5 (good / excellent) were grouped as positive responses, as shown in Table 5.

Tabla 5. Porcentaje acumulado por tipo de respuesta para cobertura y calidad de cada aspecto

Aspecto	**Mínimo / Bajo**	**Regular**	**Bueno / Excelente**
Materiales, académicos y administrativos [cobertura]	10	32	58
Materiales, académicos y administrativos [calidad]	11	32	56
Diseño curricular [cobertura]	20	35	45
Diseño curricular [calidad]	18	36	46
Docentes	13	33	54

Fuente: Elaboración propia

Regarding the “material, academic and administrative aspects”, the coverage was positioned in 58% of positive responses, and the quality obtained 56% of positive responses. In relation to the "particular aspects of curricular design", coverage obtained 45% positive responses, and quality 46%. Finally, regarding the "particular aspects of teachers", the graduates evaluated them with 58% positive responses.

Research question three

The third and final research question was designed to identify INCO's strengths and weaknesses from the perspective of graduates. The answer to this question was obtained from the discussion guide or GD, which was applied to a focus group made up of 13 graduates of both sexes and of various generations.

A moderator carried out the discussion where she took notes and recorded the audio of the session. In order to preserve absolute impartiality and to guarantee the anonymity of the participants, the moderating teacher was outside the race.

After collecting the opinions that arose during a discussion that lasted about two hours, and after analyzing the notes of the moderator and the recording, it was found that the graduates consider the two main strengths of INCO: 1) the design of the curricular mesh, since they mentioned that the way it was structured is what benefits them the most at the end of the degree, because, in this way, they can carry out their professional practices at the end of all their credits, without having to take an additional semester, 2) professional practices, since they expressed that these meant graduating from the career with a guaranteed job in the same place where they practiced.

As the main weaknesses of the degree, the graduates pointed to the teaching staff and the campus equipment and infrastructure. It is understood that, for them, teachers should have more developed their hard skills, that is, mastery of the subjects of the subjects they teach, and the development of their competencies in the use of teaching resources and strategies.

From the equipment and infrastructure, it is understood that they are not the most appropriate and modern. The results indicated that the specialized equipment for laboratory practices in both career orientations or specialties does not meet the expected standards in terms of coverage and quality.

Conclusions

Based on the results obtained (and responding to the first research question: is there a correspondence between the INCO curriculum and the objectives established in the institutional document that supports the creation of the curriculum?), It was determined that there is a correspondence between the achievements of Computer Engineering and the objectives set out in the curriculum, because the knowledge, abilities and skills, attitudes and values that are stipulated in the career graduation profile are being developed.

However, there are two aspects to improve for INCO to achieve all its proposed objectives. On the one hand, in the Systems Software orientation, students are required to develop skills and abilities concerning the design and conception of new programming languages. On the other, and where more attention must be paid, it is necessary to ensure that students, from the Digital Systems orientation, develop skills and abilities in a) design and

implementation of software tools necessary for the management of hardware, b) conception , design and construction of hardware that is functional and for specific purposes, and c) conception, design and construction of information transmission and communication systems.

In general terms, the results were positive; however, as already mentioned in the previous paragraph, there are red flags that require special attention. Table 6 helps to have a better overview regarding the correspondence between the achievements of the career and the objectives set out in the curriculum, that is, what the curriculum is achieving and what it is not.

Tabla 6. Resumen de los resultados de la primera pregunta de investigación

Conocimientos (dominio teórico práctico en…)	**¿Se desarrolla?**
Arquitectura de computadoras	Sí
Redes	Sí
Programación	Sí
Tratamiento de la información	Sí
Interacción hombre-máquina	Sí
Entorno social	Sí
Habilidades y destrezas [generales]	
Planeación, diseño, administración, implementación y producción de sistemas	Sí
Técnicas experimentales, analíticas e innovadoras para la solución de problemas	Sí
Diseño e implementación de arquitectura de computadora y desarrollo de *software*	Sí
Habilidades y destrezas [Software de Sistemas]	
Diseño y desarrollo de sistemas de *software* de base	Sí
Interacción con subsistemas digitales y de telecomunicaciones	Sí
Diseño e implementación de sistemas operativos	Sí
Diseño y concepción de nuevos lenguajes de programación	No
Habilidades y destrezas [Sistemas Digitales]	
Diseño e implementación de herramientas de *software* necesarias para el manejo del *hardware*	No
Concepción, diseño y construcción de *hardware* que sea funcional y para fines específicos	No
Concepción, diseño y construcción de sistemas de transmisión y comunicación de información	No
Diseño, construcción, instalación, operación y mantenimiento a sistemas digitales e interfaces	Sí
Actitudes y valores	
Responsabilidad, profesionalismo y búsqueda de la calidad	Sí
Superación continua	Sí
Disciplina, tenacidad y autoexigencia	Sí
Creatividad (para diseñar y desarrollar sistemas)	Sí

Fuente: Elaboración propia

Responding to the second research question (what is the level of academic satisfaction of INCO graduates?), And from the results obtained, it was concluded that the level of satisfaction is located in the range between fair and high, since The general mean was placed at 3.5 on a scale that includes the following parameters: 1) minimal, 2) low, 3) regular, 4) high, and 5) very high.

The least satisfactory for graduates is related to curriculum design. For them, the coverage (in the study plan) in terms of specific subjects that respond to the needs demanded by the world of work is the least favorable for the study plan. Standing at 2.98, the average in this regard was the lowest of all. In other words, the level of satisfaction ranged from low to fair.

Finally, in response to the third research question (what are the strengths and weaknesses of INCO from the perspective of graduates?), And although it may seem contradictory to what was said in the previous paragraph, for graduates the design of the curricular mesh is the main strength of the career. Professional practices is the other strength that graduates of INCO see. Likewise, it is concluded that the main weaknesses of the degree are the teaching staff and the campus equipment and infrastructure.

In conclusion, the tools (knowledge, abilities and skills, attitudes and values) that INCO is providing to its students are a decisive factor so that upon graduation they can be employed in the field of computing. However, it would be pertinent to go even further into the INCO curriculum.

On the one hand, it is necessary to evaluate the curriculum from the three remaining phases of the CIPP model: context, input and process. It must be remembered that this evaluation was carried out in the last stage of the model: product. A complete evaluation of the curriculum would allow the authorities in charge of INCO to make better, more efficient and effective decisions.

Establishing a process of continuous and systematic evaluations of the curriculum would allow gathering up-to-date information, in order to identify and satisfy the most essential needs. This would serve to make the best use of resources and to compare the progress observed from previous evaluations.

Another line of research would allow us to identify how or in what way to raise the level of development of those abilities and skills in which the graduates left low. In this way, all the objectives set out in the INCO curriculum would be met.

Finally, another study would be pertinent to identify the level of development of hard and didactic competences of INCO teachers. In this way, the authorities would know how to focus their efforts to help the development of these skills.

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