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Artículos Científicos

Conocimientos matemáticos de los estudiantes de primer ingreso del CUValles de la Universidad de Guadalajara

Mathematical Knowledge of First Entry Students of the Centro Universitario de los Valles of the Universidad de Guadalajara

Conhecimento matemático de alunos iniciantes no CUValles na Universidade de Guadalajara

Silvia Sánchez Díaz
Universidad de Guadalajara, Centro Universitario de los Valles, México
diazsilvia09@hotmail.com
https://orcid.org/0000-0002-4790-0503

Emilio Leonardo Ramírez Mora
Universidad de Guadalajara, Centro Universitario de los Valles, México
emiliorm@valles.udg.mx
https://orcid.org/0000-0001-9405-5392

César Calderón Mayorga
Universidad de Guadalajara, Centro Universitario de los Valles, México
cesarcm@valles.udg.mx
https://orcid.org/0000-0003-4216-1219

Rubén Sánchez Gómez
Universidad de Guadalajara, Centro Universitario de Ciencias Exactas e Ingenierías, México
dr.rsanchez@gmail.com
https://orcid.org/0000-0002-1103-3436

Resumen

En la presente investigación se analizan los conocimientos en matemáticas que tienen los estudiantes de primer ingreso de las licenciaturas de Administración, Turismo, Contaduría Pública, Tecnologías de la Información y las ingenierías en Mecatrónica, Electrónica y Computación, Instrumentación Electrónica y Nanosensores, Diseño Molecular de Materiales, Geofísica y Sistemas Biológicos. Se trata de identificar los conocimientos básicos y las deficiencias de los alumnos en esta área antes de cursar asignaturas como Matemáticas I o Precálculo (según sea el caso) para contribuir a erradicar la reprobación, el rezago y el posible abandono de los estudios de licenciatura. Se aplicó una prueba que consta de 15 reactivos de opción múltiple a 413 estudiantes de dichos programas educativos. Una vez realizado el análisis, se encontró 44.20 % de respuestas incorrectas, 52.98 % de respuestas correctas y 2.82 % de respuestas sin contestar. Se obtuvo una calificación promedio de 52.97 (reprobatoria); solo tres estudiantes contestaron correctamente los 15 reactivos; un estudiante acertó solo uno del total de reactivos. El reactivo 13, donde se requiere expresar algebraicamente el perímetro de un rectángulo a partir de una expresión verbal, obtuvo el mayor número de respuestas incorrectas, con 11.56 %. El reactivo 14, que consiste en identificar el procedimiento para resolver una ecuación de primer grado con una incógnita, registró el mayor número de respuestas correctas, con 10.69 %. Los programas que obtuvieron un promedio mayor al general (52.97) fueron las ingenierías en Mecatrónica, en Instrumentación Electrónica y Nanosensores, en Diseño Molecular de Materiales, en Geofísica y la licenciatura en Contaduría Pública; el resto tuvo una nota por debajo del promedio general. Solamente en ingeniería Mecatrónica e ingeniería Geofísica se obtuvieron promedios de calificación aprobatoria. Por lo anteriormente indicado, es necesario que en todas las licenciaturas se subsanen estas carencias, apoyándose en los cursos de Matemáticas I y Precálculo, y en específico se requiere de fortalecer los conocimientos en fracciones, exponentes, jerarquía de operaciones, ley de los signos y operaciones algebraicas.

Palabras clave: conocimientos matemáticos, educación superior, estudiantes primer ingreso, programa educativo, test.

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
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Abstract

In this research, we analyze the knowledge in mathematics that have the first entry students of the Bachelor of Administration, Tourism, Public Accounting, Information Technology and Engineering in Mechatronics, Electronics and Computation, Electronic Instrumentation and Nanosensors, Molecular Design of Materials, Geophysics and Biological Systems. The goal is to identify the basic knowledge and the deficiencies of the students in this area before taking subjects such as Mathematics I or Pre-calculus (according to the case), so that these deficiencies do not contribute to failure, backwardness and possible abandonment of undergraduate studies. A test consisting of 15 multiple choice questions was applied to 413 students of these educational programs. As part of the analysis, it was found 44.20% of incorrect answers, 52.98% of correct answers and 2.82% of unanswered answers. An average score of 52.97 (failing) was obtained; only 3 students correctly answered the 15 questions and one student got a correct answer of the 15. The item 13, which requires to express algebraically the perimeter of a rectangle from a verbal expression, was the one that obtained the highest number of incorrect answers with 11.56%. Question 14, which consists in identifying the procedure to solve a first degree equation with an unknown, was the one that obtained the highest number of correct answers with 10.69%. The educational programs that obtained an average higher than the general average (52.97) were Mechatronics Engineering, Electronic Instrumentation and Nanosensors, Molecular Design of Materials, Geophysics and the Bachelor of Public Accounting; the rest had an average below the general average. Only Mechatronic Engineering and Geophysical Engineering students obtained passing grades averages. It is necessary that all bachelor's degrees correct these gaps, relying on the courses of Mathematics I and Precalculus. It is necessary to strength knowledge of fractions, exponents, hierarchy of operations, law of signs, and algebraic operations.

Keywords: mathematics knowledge, higher education, first entry students, educational program, test.

Resumo

Esta pesquisa analisa os conhecimentos matemáticos dos alunos do primeiro ano do Bacharelado em Administração, Turismo, Contabilidade Pública, Tecnologia da Informação e engenharia em Mecatrônica, Eletrônica e Computação, Instrumentação Eletrônica e Nanossensores, Projeto Molecular de Materiais, Geofísica e Sistemas Biológicos. O objetivo é identificar o conhecimento básico e as deficiências dos alunos nessa área antes de cursar matérias como Matemática I ou Pré-cálculo (conforme o caso) para ajudar a erradicar o fracasso, o atraso e o possível abandono dos estudos de graduação. Um teste composto por 15 itens de múltipla escolha foi aplicado a 413 estudantes dos referidos programas educacionais. Após a análise, foram encontrados 44,20% de respostas incorretas, 52,98% de respostas corretas e 2,82% de respostas não respondidas. Foi obtida uma nota média de 52,97 (reprovada); apenas três alunos responderam os 15 itens corretamente; um aluno correspondeu a apenas um do número total de itens. O reagente 13, em que é necessário expressar algebricamente o perímetro de um retângulo a partir de uma expressão verbal, obteve o maior número de respostas incorretas, com 11,56%. O reagente 14, que consiste em identificar o procedimento para resolver uma equação de primeiro grau com uma variável desconhecida, registrou o maior número de respostas corretas, com 10,69%. Os programas que obtiveram média mais alta que a média geral (52,97) foram de engenharia em mecatrônica, instrumentação eletrônica e nanossensores, design de materiais moleculares, geofísica e graduação em contabilidade pública; o restante ficou abaixo da média geral. Somente na engenharia mecatrônica e na engenharia geofísica foram obtidas as médias das notas de aprovação. Pelo exposto, é necessário que essas deficiências sejam corrigidas em todos os graus, contando com os cursos de Matemática I e Pré-cálculo, e especificamente é necessário fortalecer o conhecimento em frações, expoentes, hierarquia de operações, lei de sinais e operações algébricas.

Palavras-chave: conhecimento matemático, ensino superior, alunos da primeira entrada, programa educacional, teste.

Fecha Recepción: Enero 2020 **Fecha Aceptación:** Mayo 2020

Introduction

The University Center of the Valleys (CUValles) of the University of Guadalajara provides higher education in the Valles region of the state of Jalisco, Mexico. It has two cycles of admission of students to its different degrees: the first one in January (cycle A) and the second in August (cycle B).

The students come mainly from different baccalaureates in the region where the university center is located, such as regional high schools, modules and extensions of the University of Guadalajara, as well as baccalaureates from the state and federal educational system, including the Industrial and Services Technological Studies (Cetis) and the Industrial and Services Technological Baccalaureate Center (Cbtis), as well as the State College of Jalisco (Cobaej). It should be noted that students from other municipalities of the state also enter, as well as from other states of the country.

For admission, the College Board Academic Aptitude Test is applied. The score obtained in this test represents 50% of the admission score, the other 50% is provided by the average of your high school certificate.

The entrance of a student to a bachelor's degree depends on these two factors together with the admission quota established for each bachelor's degree, therefore students whose sum of these two percentages are the highest are admitted until completing the quota established in each cycle. school.

Often students who do not have the adequate academic training enter in order to satisfactorily study their subjects and thereby complete their degree. One of them is fundamental, the area of mathematics.

This situation is not exclusive to CUValles, as can be seen in a large number of studies that address this problem; This situation occurs in other universities in Mexico and other countries, so analyzing this problem is of great importance, since it affects students from all over the world.

Along these lines, Chen (2016) states that a high percentage of students who enter university arrive without the academic skills necessary for this educational level, which has led many universities to develop remedial courses to address this situation —although, given Since these courses cover pre-university content, the credits acquired are not counted as part of those required to graduate. Chen (2016) also underlines that the economic cost associated with these remedial courses is significant, which impacts public budgets.

Without a doubt, the baccalaureate constitutes a fundamental training stage so that the applicants have greater possibilities of entering the university, as well as to be successful in their career for the degree of their choice. In this regard, Herzog (2005) establishes that the baccalaureate is key in the retention of students, which is indisputable not only for being the pre-university step, but also for the fact that the training that takes place there impacts in a substantial in the development during the university stage.

In relation to the courses that usually present difficulties for the students in the universities, Adelman (1999, cited in Herzog, 2005) affirms that the three courses in which the students fail most in the university are all from the area of mathematics. In fact, as a result of their research, Herzog (2005) found that performance in this area is a strong indicator of possible dropout, specifically during the first and second semester of university, hence the importance of attending this training from high school .

For their part, Stone, Alfeld and Pearson (2008), taking the United States as a reference, point out that high school students are not prepared for the mathematics they will need in the post-graduation stations. They also affirm that, contrary to what has been considered, increasing the courses in this area has not been the solution. In addition to this, they mention that students disengage from mathematics due to their difficulty, lack of support or simply because of boredom; the fact that many of them believe that the mathematics they learn in school is not relevant in their lives is another factor.

Stone (2003) mentions that many students who intend to enter the university require remedial courses either in mathematics, reading or writing, or even courses from all three disciplines. On the other hand, it indicates that mathematical skills are basic for the industry, necessary not only for engineers and scientists, but for all those who want to advance their professional path.

According to Anthony (2000, cited in Whannell and Allen, 2012), there are factors that are relevant to student achievement in introductory math courses at universities: teachers identify the amount of study, lack of effort, and motivation, as well as insufficient mathematical bases, while students consider teaching, academic support and teacher pedagogy as important factors. In both cases, these are factors that certainly impact the performance of students in the initial mathematics courses, and in everything that is linked, such as failure and, in many cases, dropping out of school. Therefore, this situation is very important to be addressed from different perspectives.

Moore et al. (2010) mention that, in the case of Texas, one of the most densely populated states in the United States, a considerable percentage of high school graduates lack adequate preparation in reading and mathematics for university. In line with the above, Herges, Duffield, Martin and Wageman (2017) comment that too many students enter university without the knowledge and mathematical skills necessary to be successful and competitive. The same authors consider as factors that influence in this situation the motivation of the student, as well as the structure and characteristics of the family, which influences the achievements in the area of mathematics.

As we have seen, this situation is not exclusive to a university or country, since it usually occurs in very different contexts. This is reaffirmed by Long, Iatarola and Conger (2009), who emphasize that a high percentage of new students entering universities are not prepared for the required level in mathematics at that educational level.

For their part, Corbishley and Truxaw (2010) found that teachers perceive that, on average, new students from universities are not prepared in mathematics. Additionally, they specify in which aspects they present deficiencies: the lowest are the mastery of competences, algebraic abilities, reasoning and generalization.

However, there is an important contribution in relation to specific deficiencies: Ngo (2019) considers that, in the case of basic mathematical skills, the gaps that commonly inhibit access to higher-level courses are fluidity in procedures with fractions, solving algebraic equations and answering word problems.

And taking up Corbishley and Truxaw (2010), these researchers indicate that being college ready involves having specific math skills. They suggest that in order to improve the situation, it is necessary, among other actions, to increase expectations and improve mathematical preparation in the stages prior to university.

In the case of mathematics, it is often thought that increasing mathematics courses in high school will help ensure that graduates of this educational level achieve better training, however, Teitelbaum (2003) states that this type of action does not improve the mastery in this area.

Problematizing this point a little more, Long et al. (2009), when analyzing the impact of taking advanced mathematics courses in high school, observed that not all students benefit from it, and attribute the differences to the rigor and quality of learning environments, but, unlike Teitelbaum (2003), consider that the courses students take in high school contribute to make them college ready, in particular they point to the Algebra 2 course as having the greatest impact, this in the particular context of the United States.

Following the above, increasing the number of mathematics courses in high school may be a strategy to consider for its application in the context of high schools in the Valles region, which is the main area of influence of CUValles.

Despite the cultural, economic and social differences of the countries, there is agreement on the current problem among students who graduate from high school and enter the university, in the specific case, academic deficiencies in training in mathematics.

Part of the importance of evaluating how high school students reach universities in mathematics training, and specifically at CUValles, has to do with what Camara (2013) exposes, whose research shows that cognitive measures of academic performance, such as Baccalaureate grades and test results are highly predictive of college grades. It should be noted that, in more than a few cases, the students who enter the CUValles present an average of high school grades that does not necessarily coincide with the score of the academic aptitude test they present for their admission, including scores in the area of mathematics.

Objective

The objective of this research is to identify the basic knowledge in mathematics of the first-year students of the degrees of Administration, Tourism, Public Accounting, Information Technology and engineering in Mechatronics, Electronics and Computing, Electronic Instrumentation and Nanosensors, Molecular Design of Materials, Geophysics and Biological Systems. This to strengthen the deficiencies found and thus they are not a factor of failure, lag and, in the worst case, abandonment of undergraduate studies.

Methodology

The information was obtained through the application of an exam in which basic mathematical knowledge was evaluated, which was considered based on the upper secondary level study programs. It was determined as a study universe the total of first-year students of the Bachelor's degree in Information Technology, Engineering in Mechatronics, Engineering in Electronics and Computation, Engineering in Electronic Instrumentation and Nanosensors, Engineering in Molecular Materials Design, Engineering in Geophysics, Engineering in Biological Systems, Bachelor of Administration, Bachelor of Tourism and Bachelor of Public

Ride Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Accounting from CUValles of the University of Guadalajara of the 2019B cycle (August 2019-January 2020). The test was applied in the first session of each of the groups and only pencil and eraser were allowed.

The exam that was applied consisted of 15 multiple-choice items (see annex). Taken together, the items required basic knowledge of arithmetic operations such as adding and multiplying fractions, the hierarchy of operations, laws of signs and exponents, development of the square of a binomial, translation from natural language to mathematical language, translation of geometric information into algebraic language and solution of linear and quadratic equations.

Statistical analysis was performed using the Excel and Minitab programs. Table 1 summarizes the composition of the population. The responses of first-time students from 10 CUValles degrees were analyzed.

Tabla 1. Distribución de la población por programa educativo

Programa educativo	**Total de alumnos**
Licenciatura en Tecnologías de la información	32
Ingeniería en Mecatrónica	54
Ingeniería en Electrónica y Computación	34
Ingeniería en Instrumentación Electrónica y Nanosensores	33
Ingeniería en Diseño Molecular de Materiales	20
Ingeniería en Geofísica	17
Ingeniería en Sistemas Biológicos	35
Licenciatura en Administración	72
Licenciatura en Turismo	36
Licenciatura en Contaduría Pública	80
Total	413

Fuente: Elaboración propia

Results

Thanks to the analysis of the information obtained, it was possible to identify the number of correct, incorrect and unanswered responses of the total number of students, which can be seen in Table 2.

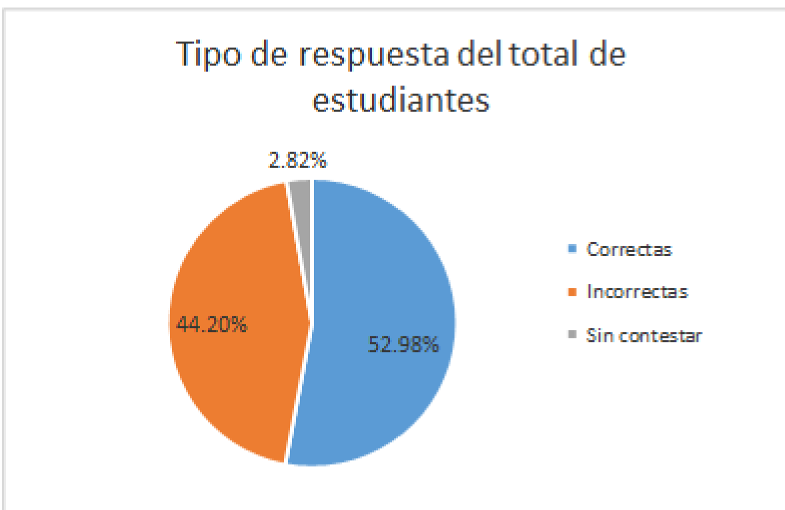
Tabla 2. Distribución de las respuestas para el total de estudiantes.

Tipo de respuestas	Frecuencia
Correctas	3282
Incorrectas	2738
Sin contestar	175

Fuente: Elaboración propia

Likewise, figure 1 shows that 52.98% of the answers were correct, while 44.20% were incorrect.

Figura 1. Clasificación de tipo de respuesta para el total de estudiantes



Fuente: Elaboración propia

Table 3, for its part, shows how many students obtained a certain number of correct answers. It is observed that the highest frequencies are between 4 and 12 hits; three students correctly answered all 15 items, and only one student matched two items. In addition, 14.73% of the students answered seven questions correctly, this is the highest percentage recorded in the table and is equivalent to a score of 46.66 on the scale of 0 to 100, which is also illustrated in Figure 2.

Table 4 shows the frequency of each correct, incorrect and unanswered reagent also expressed as a percentage. As can be seen in figure 3, the item that most students answered correctly is 14 (327 students), with 10.69%. This question refers to the identification of the correct procedure to solve a first degree equation with an unknown factor. Next, item three (326 students) was located, with 10.6 5%, which refers to the application of the hierarchy of operations. Then comes item 12 (324 students) with 10.59%. In this item, you are asked to calculate the area of a rectangle using a drawing divided into two rectangles with known and unknown lengths.

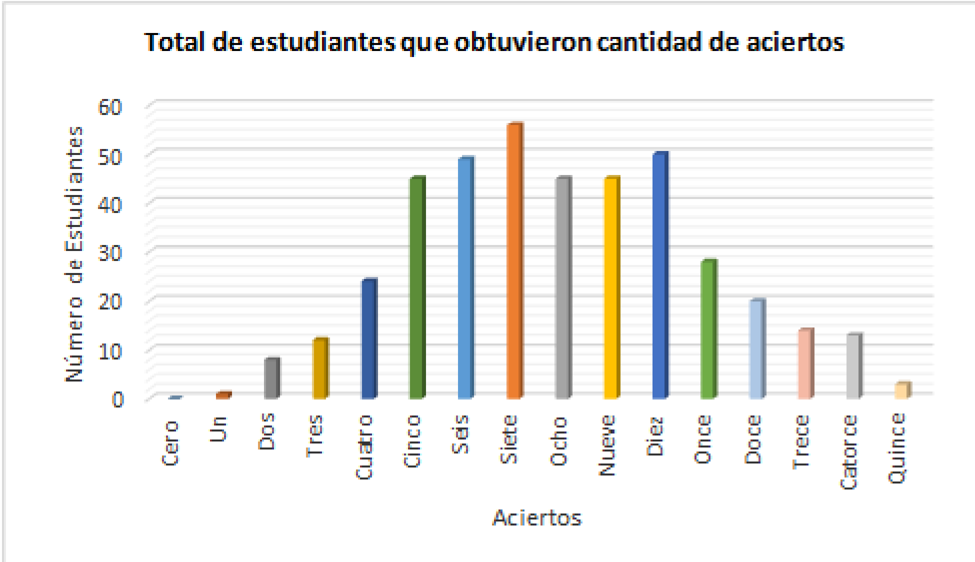
Tabla 3. Total de estudiantes que obtuvieron cantidad de aciertos

Cantidad de aciertos	Cantidad de estudiantes	Porcentaje
1	0	0
2	1	0.26
3	8	2.10
3	12	3.15
4	24	6.31
5	45	11.84
6	49	12.89
7	56	14.73
8	45	11.84
9	45	11.84
10	50	13.15
11	28	7.36
12	20	5.26
13	14	3.68
14	13	3.42
15	3	0.78

Fuente: Elaboración propia

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Figura 2. Total de estudiantes que obtuvieron cantidad de aciertos



Fuente: Elaboración propia

In the same figure 3, as in Table 4, the items with the most incorrect answers are observed: number 13 with 11,562%, number five with 10,719%, number 10 with 10,558% and number 15 with 10,157%. In item 13, it is required to algebraically express the perimeter of a rectangle from a verbal expression; Reagent five is to simplify an expression by applying the concepts of a similar term, sign laws, and the use of parentheses; item 10 asks to identify the development of a squared binomial, and item 15 requires solving a quadratic equation. Taking into account the above, it is consistent with what was expressed by Long et al. (2009) when they state that a high percentage of new students entering universities are not prepared for the required level in mathematics.

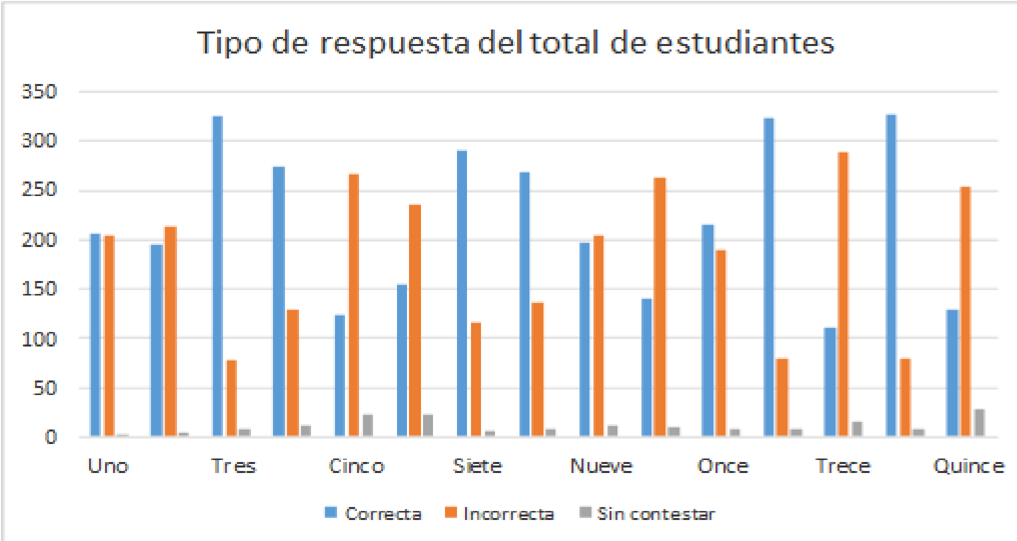
We can also see and it is noteworthy that item 15 is the one with the most students who did not answer (28 students did not answer, which represents 18.79% of the population).

Tabla 4. Total de estudiantes por tipo de respuesta

Reactivo	Correcta		Incorrecta		Sin contestar	
	Frecuencia	%	Frecuencia	%	Frecuencia	%
1	206	6.73	204	8.18	2	1.34
2	195	6.37	213	8.55	5	3.35
3	326	10.65	78	3.13	9	6.04
4	273	8.92	129	5.17	11	7.38
5	124	4.05	267	10.71	22	14.76
6	155	5.06	235	9.43	23	15.43
7	291	9.51	117	4.69	6	4.02
8	269	8.79	136	5.45	8	5.36
9	197	6.43	205	8.22	11	7.38
10	140	4.57	263	10.55	10	6.71
11	215	7.02	190	7.62	8	5.36
12	324	10.59	80	3.21	9	6.04
13	111	3.62	288	11.56	15	10.06
14	327	10.69	80	3.21	8	5.36
15	129	4.21	253	10.15	28	18.79

Fuente: Elaboración propia

Figura 3. Tipo de respuesta por reactivo correctamente, incorrectamente y sin contestar



Fuente: Elaboración propia

On the other hand, in Table 5 it is possible to see that the general average obtained was 52,978, with a deviation of 19,316. This value indicates how far the data is from the mean, that is, it is an indicator that the data oscillates at this distance from the mean (Gutiérrez and Vladimirovna, 2017; Levin and Rubin, 2004). This result coincides with that obtained by Gamboa, Castillo and Hidalgo (2019), whose participants in a similar study obtained a non-passing grade..

Tabla 5. Promedio y desviación estándar del total de estudiantes

Promedio general	52.978
Desviación estándar	19.316

Fuente: Elaboración propia

Table 6 shows the average obtained by gender: the average obtained by women was 50,292 and that of men was 54,876.

Tabla 6. Promedio por género del total de estudiantes

Género	Promedio	Total	Desviación estándar
Hombres	54.876	242	19.391
Mujeres	50.292	171	18.942
		413	

Fuente: Elaboración propia

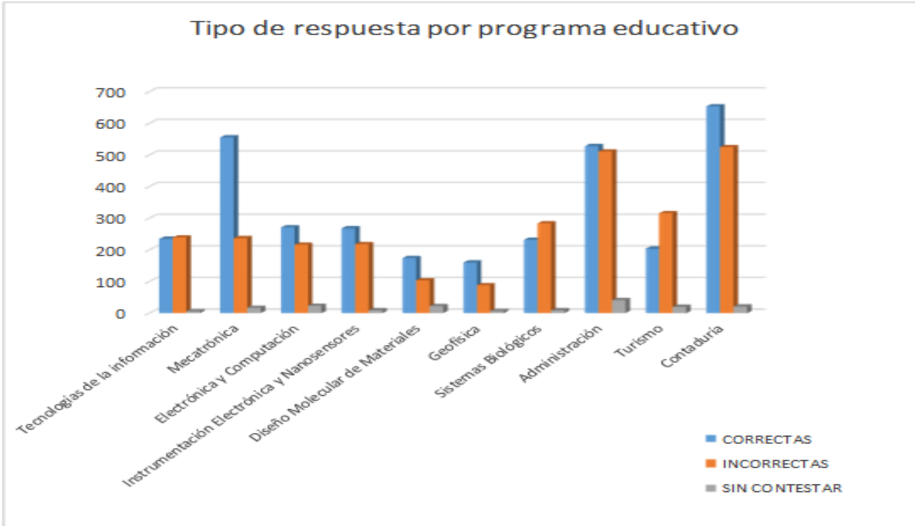
In relation to the percentage of correct and incorrect answers, when making the comparison between the educational programs, it was found that engineering students in Mechatronics obtained the highest percentage of correct answers with 68.64%, followed by engineering students in Geophysics with 62.74%. and those of engineering in Molecular Design of Materials with 58%. On the other hand, the students of the degree in Tourism obtained the highest percentage of incorrect answers with 58.51%, followed by those of engineering in Biological Systems with 54.09% and those of the degree in Information Technology with 49.79%. Regarding the number of unanswered responses, the highest percentage was recorded by engineering in Molecular Materials Design with 7.33%, as observed in Table 7. In addition, figure 4 shows the comparison between the correct responses and wrong of students among educational programs.

Tabla 7. Número de respuestas y porcentajes por programa educativo

	Tipo de respuestas					
Programa educativo	**Correctas**	**%**	**Incorrectas**	**%**	**Sin contestar**	**%**
Licenciatura en Tecnologías de la información	235	48.95	239	49.79	6	1.25
Ingeniería en Mecatrónica	556	68.64	237	29.25	17	2.09
Ingeniería en Electrónica y Computación	271	53.13	216	42.35	23	4.50
Ingeniería en Instrumentación Electrónica y Nanosensores	268	54.14	218	44.04	9	1.81
Ingeniería en Diseño Molecular de Materiales	174	58	104	34.66	22	7.33
Ingeniería en Geofísica	160	62.74	88	34.50	7	2.74
Ingeniería en Sistemas Biológicos	232	44.19	284	54.09	9	1.71
Licenciatura en Administración	528	48.88	511	47.31	41	3.79
Licenciatura en Turismo	204	37.77	316	58.51	20	3.70
Licenciatura en Contaduría Pública	654	54.5	525	43.75	21	1.75

Fuente: Elaboración propia

Figura 4. Tipo de respuesta por programa educativo



Fuente: Elaboración propia

Revista Iberoamericana para la Investigación y el Desarrollo Educativo
ISSN 2007 - 7467

Tabla 8. Porcentaje de respuestas correctas por reactivo y por programa educativo

	Lic. en Tecnologías de Información	Ing. en Mecatrónica	Ing. en Electrónica y Computación	Ing. en Instrumentación	Ing. en Diseño Molecular de	Ing. en Geofísica	Ing. en Sistemas Biológicos	Lic. en Administración	Lic. en Turismo	Lic. en Contaduría
R1	25	68.51	41.17	63.63	45	88.23	45.71	50	30.55	48.75
R2	25	79.62	38.23	54.54	65	94.11	28.57	34.72	16.66	53.75
R3	59.375	96.29	88.23	93.93	85	70.58	85.71	75	58.33	75
R4	71.875	94.44	58.82	78.78	65	64.70	45.71	63.88	41.66	65
R5	46.875	33.33	38.23	18.18	5	58.82	20	30.55	22.22	30
R6	34.375	51.85	41.17	9.09	45	29.41	48.57	37.5	25	40
R7	65.62	72.22	61.76	69.69	70	82.35	74.28	75	72.22	66.25
R8	46.87	75.92	73.52	72.72	75	64.70	54.28	58.33	55.55	71.25
R9	43.75	64.81	58.82	57.57	65	70.58	28.57	37.5	25	47.5
R10	34.375	59.25	23.52	36.36	25	76.47	20	25	19.44	33.75
R11	56.25	61.11	58.82	60.60	70	35.29	40	51.38	41.66	47.5
R12	84.37	83.33	94.11	69.69	95	64.70	74.28	69.44	58.33	87.5
R13	34.37	46.29	20.58	27.27	45	11.76	11.42	18.05	19.44	30
R14	81.25	96.29	85.29	69.69	75	76.47	65.71	77.77	63.88	83.75
R15	25	46.29	14.70	30.30	40	52.94	20	29.16	16.66	37.5

Fuente: Elaboración propia

Table 8 shows the percentage of the correct answers recorded by each educational program in each of the items. It is possible to observe that engineering in Mechatronics has the highest percentage of correct hits in items three (hierarchy of operations), four (distributive property and law of signs), six (distributive property of division), eight (multiplication of monomials with a same base and different exponent), 13 (natural language to mathematical translation) and 14 (solution of a linear equation in one variable); Engineering in Geophysics has a higher percentage of correct answers in the reactants one (multiplication of fractions), two (division of fractions), five (signs and exponents), seven (law of exponents), nine (division of monomials with the same base), 10 (binomial squared) and 15 (solution quadratic equation); the educational engineering program in Molecular Materials Design has a higher percentage in items 12 (translate visual information into mathematical language) and three (hierarchy of operations). It can also be seen that reagent five (signs and exponents) has the lowest percentage, followed by reagent six (distributive property of the division), in the engineering program in Electronic Instrumentation and Nanosensors. Furthermore, item 13 (translation from natural language to mathematics), in the Geophysics engineering education program, has a low percentage of correct answers. In addition to this, Reagent 15 (Quadratic Equation Solution) also has a low percentage of correct answers by the participants in Electronic and Computer Engineering. Here it coincides with what Ngo (2019) points out when stating that the skill gaps that commonly inhibit access to higher level courses are the fluency in procedures with fractions, the solution of algebraic equations and the answer to word problems.

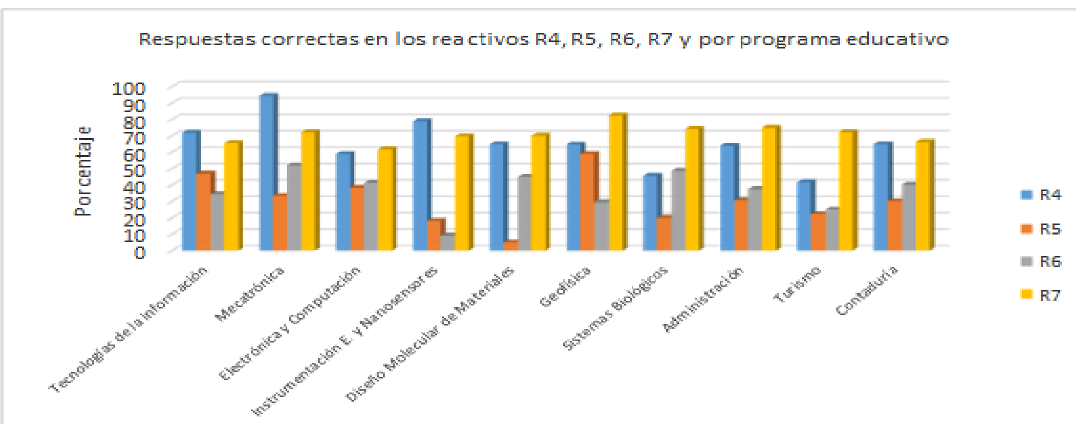
Figure 5 shows the correct answers for items one, two and three by educational program. In item one, the highest percentage of correct answers were obtained by engineering students in Geophysics and the lowest by those with a Bachelor's degree in Information Technology. In item two, the highest percentage of correct answers were also obtained by engineering students in Geophysics and the lowest by those with a Bachelor's degree in Tourism. Finally, regarding item three, the highest percentage of correct answers were obtained by engineering students in Mechatronics and the lowest by those with a Bachelor's degree in Tourism.

Figura 5. Respuestas correctas en los reactivos uno, dos, tres por programa educativo

Fuente: Elaboración propia

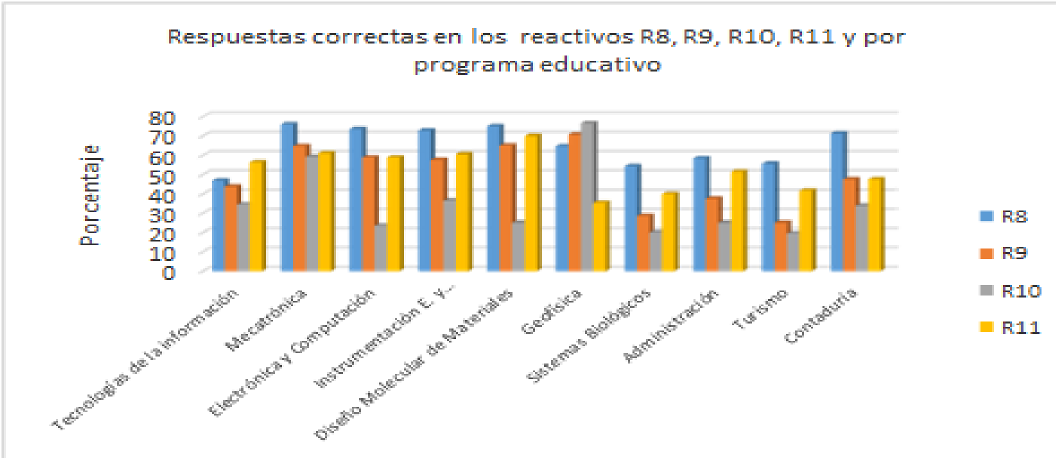
Figure 6 shows that almost all students in the Mechatronics Engineering Education Program, 94.4%, answered item four correctly. Engineering in Molecular Design of Materials recorded that the reagent that answered the least correctly was five, with 5%. It should be noted that this reagent is the one that is most complicated for the students of the different educational programs, with the exception of those for engineering in Geophysics and engineering in Electronic Instrumentation and Nanosensors.

Figura 6. Respuestas correctas en los reactivos 4, 5, 6 y 7 por programa educativo



Fuente: Elaboración propia

Figura 7. Respuestas correctas en los reactivos 8, 9, 10 y 11 por programa educativo

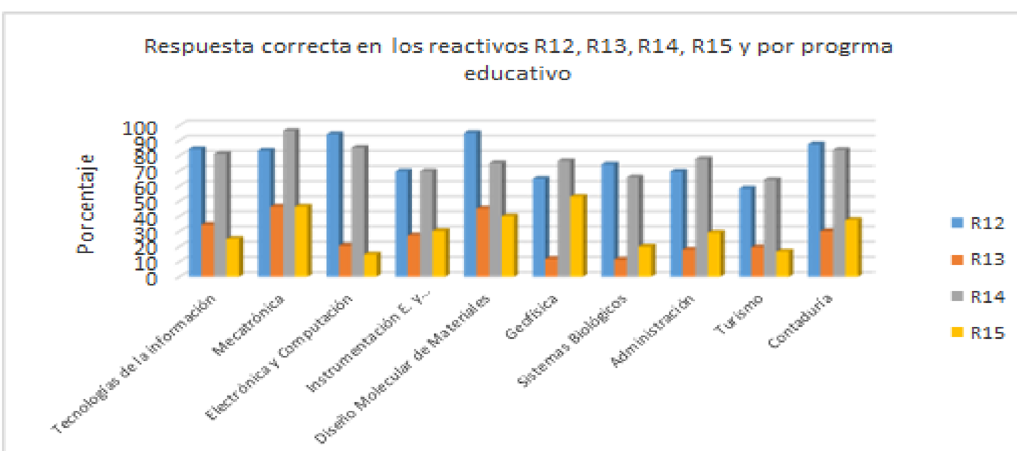


Fuente: Elaboración propia

In figure 7 it can be seen, for its part, that the students of the engineering program in Mechatronics are the ones who obtained the highest percentage of correct answers in item eight, while in the case of item nine the highest percentage was obtained by engineering in Geophysics. On the other hand, it is observed that in item 10 all the educational programs had a low percentage of correct answers, except engineering in Geophysics.

Finally, the graph in figure 8 shows that items 12 and 14 were those that obtained the highest percentage of correct answers in all educational programs, while in items 13 and 15 the percentages were low for all educational programs.

Figura 8. Respuestas correctas en los reactivos 12, 13, 14 y 15 por programa educativo



Fuente: Elaboración propia

Ride
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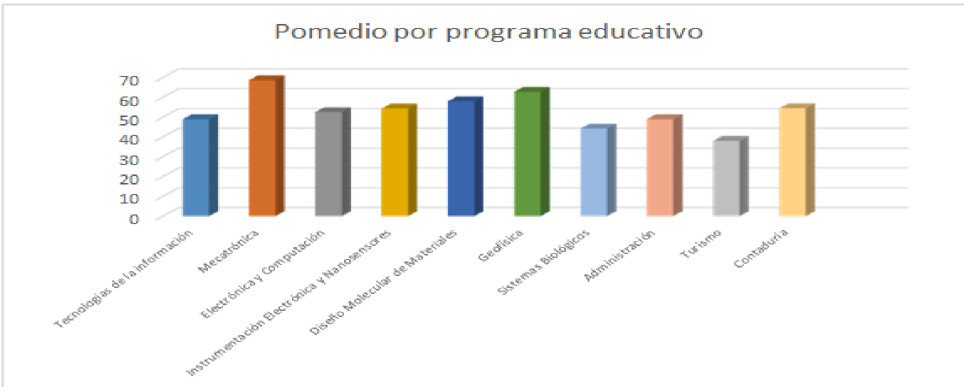
As is evident in the results previously described, the students present deficiencies in basic knowledge of mathematics, a situation similar to that found Gamboa *et al.* (2019).

Figura 9. Promedio por programa educativo



Fuente: Elaboración propia

However, figure 9 shows the average grades of the students of the various educational programs. There it can be seen that the highest average was obtained by engineering students in Mechatronics and the lowest by those with a degree in Tourism. With regard to this, it highlights that the majority of the averages are not passing, so it coincides with what was expressed by Corbishley and Truxaw (2010), who affirm that teachers perceive that, on average, new students from universities do not they are prepared in mathematics.

Table 9 presents the average and standard deviation by educational program. It is observed that the highest average is held by the Mechatronics engineering education program, with a standard deviation of 18,389 (this means that all the data oscillate between a range of this amount above the mean and this amount below the mean) ; The engineering education program in Geophysics follows, with an average of 62,745, but its standard deviation is greater than in Mechatronics engineering. The educational program with the lowest average is a Bachelor of Tourism, also with a smaller standard deviation than all educational programs, which means that the vast majority are around that average.

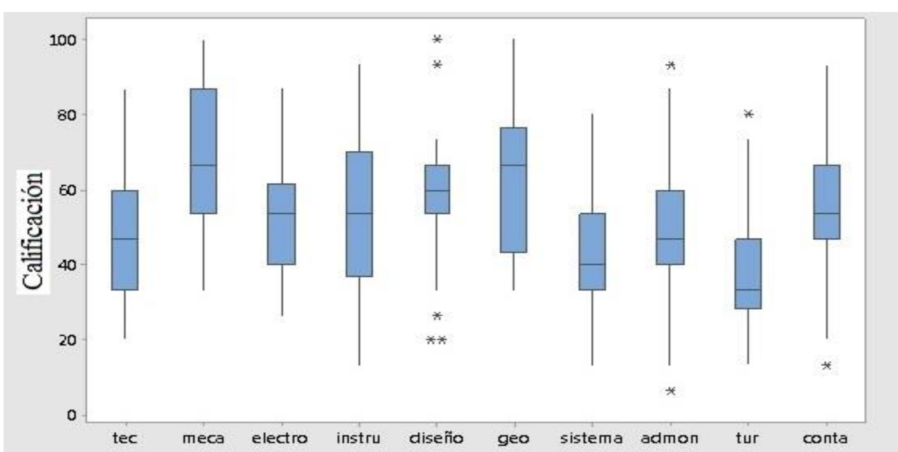
A box plot shows the dispersion or separation of the data. The dispersion can be measured by the length or range of the diagram, since from the minimum to the maximum value the entire data would be, so that within the box 50% of the data would be represented (from the first quartile to the second quartile is 25% of the data, the second quartile is the median and from this to the third quartile is another 25% of the data); dispersion within the box is measured by the interquartile range, that is, the third quartile minus the first quartile will express the variability of 50% of the data (Gutiérrez y Vladimirovna, 2017; Levin y Rubin, 2004).

Tabla 9. Promedio de los estudiantes por programa educativo

Programa educativo	Promedio	Desviación estándar
Licenciatura en Tecnologías de la información	48.958	16.984
Ingeniería Mecatrónica	68.641	18.389
Ingeniería en Electrónica y Computación	52.549	16.637
Ingeniería en Instrumentación Electrónica y Nanosensores	54.343	21.023
Ingeniería en Diseño Molecular de Materiales	58	20.869
Ingeniería en Geofísica	62.745	19.868
Ingeniería en Sistemas Biológicos	44.19	16.887
Licenciatura en Administración	48.981	17.121
Licenciatura en Turismo	37.96	16.237
Licenciatura en Contaduría	54.5	16.356

Fuente: Elaboración propia

Figura 10. Comparación de calificaciones por programa educativo



Fuente: Elaboración propia

Figure 10 shows the box diagrams of each educational program taking the grade. The Molecular Materials Design engineering educational program has a lower interquartile range compared to all; It has less variability of the data because the length of the box is shorter, although it has five outliers, since it has two values of 20, a value of 26,666, a value of 93,333 and another 100.

The programs with the highest value of the median (Q_2 = 66,666) are engineering in Mechatronics and engineering in Geophysics, but that one is closer to the first quartile (Q_1), that is, the upper data of the median are more separated upwards or towards the third quartile (Q_3), while in this the median is closer to the third quartile (Q_3), the data below the median are more separated downwards or towards Q_1. These two educational programs have the same minimum value (33,333) and the same maximum value (100), without any outliers.

The educational programs with the same median (Q_2 = 53,333) are Engineering in Electronic Instrumentation and Nanosensors, Accounting and Engineering in Electronics and Computation. In the case of engineering in Electronic Instrumentation and Nanosensors, it is observed that the median is in the middle of the first and third quartiles, this means that it has the same amount of data from the median towards each of the quartiles (Q_1 y). While in Electronics and Computer Engineering the median is closer to Q_3, the data is biased downward (to Q_1). Finally, in the degree in Accounting the median is closer to Q_1, the data is biased upwards (to Q_3); This program also has an outlier of 13.3333.

The bachelor's degree in Information Technology and the bachelor's degree in Administration have the same median value (Q_2 = 46,666), but the former's box is more widely dispersed than that of the latter, and the first quartile is higher in the bachelor's degree in Administration and the median of this is closer to the first quartile, the data is biased to the third quartile. In addition, this program has two outliers, one of 6,666 and the other of 93. The maximum value of both that was taken to form the diagram is 86,666 and the minimum in the Bachelor's degree in Administration is 13,333 and in Technology 20; the third quartile of both educational programs is the same.

The educational program with the lowest median and lowest interquartile range corresponds to the degree in Tourism. It has a median value of $Q_2 = 33.3333$, the value of the first quartile of $Q_1 = 28.3333$ and the value of the third quartile is $Q_3 = 46.666$.

Following the results described in this section, the findings found here are analogous to those found by Ngo (2019), since he states that the skill gaps that inhibit access to higher-level courses are related to fractions, solving equations algebraic and the answer to word problems, which were included in the instrument that was applied to the first-time students of CUValles.

Discussion

The study was limited to the educational programs that carry mathematics in their curriculum, so, to have the full view of CuValles, the inclusion of the other educational programs offered there could be considered.

On the other hand, the study only considered first-year students from one school year, and it could also be extended to other semesters to verify if the results have significant differences. In addition to the above, the students considered in the study in subsequent semesters could be followed up, in order to identify if they improved their mathematical knowledge.

However, with the study it was possible to identify the knowledge in mathematics with which students enter CUValles, as well as the deficiencies, which is of great importance, as stated by Ayebo, Ukkelberg and Assuah (2017), since that with this you can have a starting point to support them in what they need to improve.

Among the strengths of the study we could point out that this allowed us to identify the mathematics knowledge of first-year students from educational programs that take math courses to implement a teaching proposal for those who need to improve their skills in this area. On the other hand, it also allowed, as in Tenorio, Martín and Bermudo (2015), to observe that the students lack basic mathematical knowledge, which must have been acquired in high school and even in high school. In the same sense, Ayebo et al. (2017) state that many of the students who enter university have poor preparation for the mathematics studied in university. Consequently, this study seeks that high school teachers know what their students are required to learn, what they will need at university, so that in this way they can be directed in that direction. The importance of the study, as well as the results obtained, go beyond just identifying the mathematical knowledge with which the students enter, since, once again following Ayebo et al. (2017), one of the great factors that influence whether or not a student is prepared for their university journey is the level of knowledge in mathematics that the students obtained in high school, so that this study may have elements that address the problems identified at the institutional level.

Conclusions

From the information obtained, it can be deduced that the students entering the Bachelor of Administration, Tourism, Public Accounting, Information Technology and engineering in Mechatronics, Electronics and Computation, Electronic Instrumentation and Nanosensors, Molecular Design of Materials, Geophysics and Systems Biologicals in the CUValles of the University of Guadalajara present deficiencies in basic mathematical knowledge.

The educational programs that obtained a higher average than the general average (52.97) were engineering in Mechatronics, in Electronic Instrumentation and Nanosensors, in Molecular Materials Design, in Geophysics and a degree in Public Accounting; the rest of the educational programs had an average below the general average.

Mechatronics and Geophysics engineering students are the only ones to obtain an average passing grade, with 68,641 and 62,745 respectively. The rest of the educational programs obtained an average failing grade.

It is necessary to work in the Mathematics I and Precalculus courses, which the first-time students of the aforementioned degrees take in the first semester, in order to fill the gaps in the basic mathematical knowledge necessary for the start of their studies. Particularly, the areas with the highest priority for attention are: fractions, exponents, hierarchy of operations, law of signs and algebraic operations in general.

It is considered of relevant importance to share this information with the upper secondary schools from which the students entering CU Valles come, in order to guide them towards the implementation of necessary strategies to improve these results.

On the other hand, in order to monitor the progress made during the first school year of the students in CUValles, it is recommended to apply an initial exam, as well as a final one, to verify if there is improvement in basic knowledge of mathematics, and if necessary, undertake actions that support the development of the Mathematics I and Precalculus courses. It is also convenient to continue this study for several semesters in order to have a clearer view of the most common errors of the students, and to take, at the same time, the appropriate measures for their possible correction.

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Rol de Contribución	Autor (es)
Conceptualización	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Metodología	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Software	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Validación	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Análisis Formal	Silvia Sánchez Díaz «principal» Emilio Leonardo Ramírez Mora «que apoya» César Calderón Mayorga «que apoya» Rubén Sánchez Gómez «apoyo»
Investigación	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Recursos	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «igual»
Curación de datos	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Escritura - Preparación del borrador original	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Escritura - Revisión y edición	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Visualización	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Supervisión	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»

Administración de Proyectos	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»
Adquisición de fondos	Silvia Sánchez Díaz «igual» Emilio Leonardo Ramírez Mora «igual» César Calderón Mayorga «igual» Rubén Sánchez Gómez «apoyo»