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ARTICULO ORIGINAL

GESTIÓN DEL CONOCIMIENTO

Academic Performance and Saber Pro Test Results in Industrial Engineering Students

Rendimiento Académico y Resultados de Pruebas Saber Pro en Estudiantes de Ingeniería Industrial

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ABSTRACT

The article aims to present the management by competencies within two service-oriented entities, but organized by different forms of management. Documentary analysis, interviews, Delphi by rounds, questionnaire were used as methods, allowing an initial diagnosis of the aforementioned approach and the determination of the competency system. ARQDECONS management has achieved to assess its staff and to design an appropriate training process, taking into account observed development of their competencies. At CENCEC organization, the organizational competencies were updated along with their conceptualizations, prior to redesign the rest of the system. The most relevant results include the use of the competency approach in two entities from dif-

ferent sectors. Both experiences are useful as a reference to achieve greater intentionality and efficiency in the Training and Performance Evaluation processes.

Keywords: *Job Competencies, management, human capital.*

Resumen
El artículo tiene como objetivo presentar la gestión por competencias dentro de dos entidades orientadas a servicios, pero organizadas por diferentes formas de gestión. Se utilizaron como métodos el análisis documental, entrevistas, Delphi por rondas, cuestionario, que permitieron un diagnóstico inicial del abordaje mencionado y la determinación del sistema de competencias. La dirección de ARQDECONS ha logrado evaluar a su personal y diseñar un proceso de formación adecuado, teniendo en cuenta el desarrollo observado de sus competencias. En la organización CENCEC se actualizaron las competencias organizacionales y sus conceptualizaciones, previo al rediseño del resto del sistema. Los resultados más relevantes incluyen el uso del enfoque de competencias en dos entidades de diferentes sectores. Ambas experiencias sirven de referencia para lograr una mayor intencionalidad y eficiencia en los procesos de Capacitación y Evaluación del Desempeño.

Palabras claves*: Competencias laborales, gestión, capital humano.*

I. INTRODUCTION

In all research, it is essential to collect information that allows analyzing and choosing between different approaches proposed by different authors at the national and international level and that in some way will contribute to giving foundation to the research that will be developed. Therefore, the theoretical bases can be considered as the collection of concepts and propositions typical of the problem or variables under study. Below, the rationale for developing the bibliographic review is presented, on which the research will be developed, based on publications of scientific articles in indexed journals, analyzing different characteristics and trends of authors from different countries.

In Colombia, according to "the Saber Pro exam, designed and applied once a year, is aimed at students of professional academic programs who are about to finish their cycle of Higher Education, and its presentation is an additional requirement for obtaining the academic degree [1]. Its main objectives are:

- Check the development of the competencies of the students close to completing their academic programs.
- Generate added value indicators for higher education.
- Provide inputs that allow comparisons between programs and institutions.
- Provide information for the construction of indicators for evaluating the quality of programs and Higher Education Institutions (HEIs)".

Continuing with the report the Saber Pro exam has a first session that is mandatory for all those who present it [2]. It consists of 5 modules that assess generic competencies (Critical Reading Module, Quantitative Reasoning Module, Citizen Competences Module, Written Communication Module, and English Module). The test also has modules associated with specific topics and contents that students can present according to their area of professional training. Each HEI can select one of the combinatorial areas offered by the ICFES, as it deems pertinent, for each of its programs.

Comments that: "programs oriented towards the development of competencies cannot claim to meet these priorities, although they are less far from them than programs focused on knowledge. He affirms that it is still essential to identify in a precise and empirical way the competencies that the students of the HEIs need, contrary to what the expression learning to learn suggests, it is not a simple methodology: you cannot learn to build knowledge without acquiring a part of it in compulsory school. From a list of twelve skills recommended by the author, which the student should acquire, it stands out: Knowing how to orient oneself in the world of work, in this great employment market, but also within companies and various communities of practice" [3].

According to what was stated by the previous author, HEIs must prepare students so that they can prevent or anticipate the adversities they have to face in life as a professional, doing it through the planning and analysis of the environment and not waiting for the professional to learn from their mistakes when they are presented with difficult situations and not repeat them, meaning by this that the engineering student must be better prepared, applying in practice the theory taught and seeking to solve problems to companies before graduating as an industrial engineer, being able to anticipate and evaluate the risks before getting into a situation with no way out. To talk about innovation, he quotes "today the prosperity of countries depends less and less on their natural resources and more and more on their educational systems," he says of his experience in the interview he conducted with Vivek Wadhwa, vice president of innovation and research at universities such as Duke and Emory, located in Silicon Valley, California[4]. Asked what is the difference between the people of Silicon Valley and those of other parts of the United States? Wadhwa replied that it is the people, in that place, there is a great agglomeration of creative minds from all over the world, who arrive attracted by the level of acceptance to ethnic, cultural, and even sexual diversity.

In conclusion, in countries like Colombia, this must try to build their own Silicon Valley, the secret of innovation lies in the talent of the people rather than in resources or economic incentives. There is a great opportunity to take advantage of young talents, well prepared and with great job skills so that they are applied to the solution of innovation problems and those they are part of this changing world for future professionals of Industrial Engineering.

According to [4] "any effort made to improve education will obtain poor results to the extent that the important role played by the student in the learning process is neglected. Learning is a complex process that depends on the mood of the student, if a student is predisposed to learning, for various reasons will not be able to achieve good learning. "

It can be said that to guarantee the quality of higher education, the impact of the factors that influence academic performance must be identified and analyzed, for which the need arises to know which are the variables that are not directly related to the pedagogical development of the university influence the performance of students. Taking as a reference the contributions of [5] we can mention the academic variables (especially those associated with previous performance and the academic

characteristics of basic education), the psychological, the socio-family and the identification.

The evaluation by the ICFES of higher education in Colombia began in 2003 through the application of specific exams aimed at various academic programs. The state quality program of higher education known as ECAES began with the evaluation of 22 higher education programs. In 2007 there were 55 programs, in this period the review focused on the assessment of specific competencies. However, because the program was not compulsory and did not have exams for each of the existing programs, not all students took the test. In 2009 the exam had changes in its structure and application due to Law 1324 and Decree 3963 of the same year, among these changes brought with it the new regulations, one of them is the presentation of the exam as a requirement to evaluate the formal education received by those who finish undergraduate programs in higher education institutions. From 2010, the ICFES begins the design and application of a new exam known as Saber Pro, this includes the evaluation of generic competencies, understood as those that all students must develop, independently of the emphasis of training, and the evaluation of common competencies to group programs with similar training characteristics. The exam is divided into five categories which are: critical reading, quantitative reasoning, written communication, English and citizenship skills; Likewise, about 42 tests of specific competencies common for different reference groups have been built. The objective of the review is to consolidate a system of monitoring and evaluation of the education sector that accounts for the achievements and difficulties of students, their access, coverage and permanence in the system and the effectiveness of the managers responsible for the provision and quality of service.

In this order of ideas, this article seeks to identify the trend of the management of the topic at an international level, through the search for articles published in indexed journals and that are hosted in different databases, determining the degree of importance of the development of the topic of academic performance and SaberPro tests, in different countries and different institutions dedicated to the realization of scientific publications with metadata (keywords) related to the topic developed in this research.

II. METHODS

To carry out the bibliographic review, databases such as Google Scholar, Science Direct, Springer Link, SciELO and Scopus were taken as a reference, in which the articles included in a period between 2014 and 2021 were extracted, covering the articles published according to the keywords: "Factors affecting academic performance", "Evaluation of higher education", "Industrial engineering knowledge" and "University knowledge tests". As a result of this search, in the last 8 years around 4,015 articles have been published regarding the research topic.

With the publications found, the documents were scanned in the RIS format, which was added to the Mendeley platform to read this information. Subsequently, an analysis of the keywords of the publications was carried out with a minimum number

of occurrences of (2), through the VOSviewer tool, and as a result, the following image can be seen in figure1:

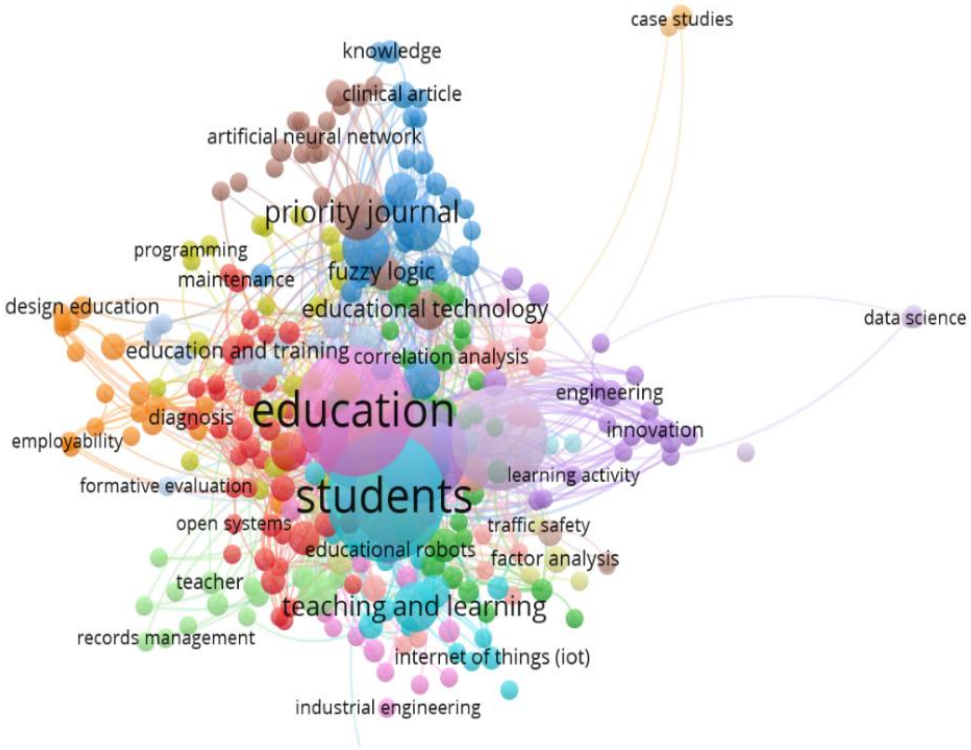


Fig. 1. Bibliometric analysis of keywords analyzed in VOSviewer

Source: Authors' research (2021)

Figure 1, generated through the VOSviewer software, shows the graph of the bibliometric analysis of Co-occurrence of the keywords taken from the Scopus database, where the topic of research on Education, learning and teaching, education design, innovation, training, and education, among others, is observed at an international level. They stand out repeatedly in the scientific publications hosted in this database.

Table 1. Recurring words from publications

Keyword	Occurrences	Total link strength
Human	45	911
Education	90	891
Student	89	813
Article	39	781
Humans	30	662
Teaching	54	489
Higher education	59	399
Engineering education	44	395
Priority journal	17	364
Controlled study	14	344
Evaluation	29	166
Higher education institutions	19	165
Evaluation study	7	135
Teaching and learning	13	131
Society and institution	10	84
Educational status	3	77
Attitude	3	70
Classification (of information)	5	61
Education and training	5	45
Educational program	4	44
Engineers	2	44
Engineering research	4	42
Motivation	6	40
Evaluation modelling	4	38
Evaluation results	5	38

Source: Authors' research (2021)

Table 1 shows the number of co-occurrences in the different publications of the keywords extracted by VOSviewer from the articles published in Scopus, and also their relationship or links in the formation of networks or clusters, reflecting the degree of alignment that the topic of research related to the human being (911), education (891) and students (813) has, focusing on the improvement of academic performance and the final tests of baccalaureate, concerning different scopes and objectives embodied by the authors in their published articles, all focused on the search for the improvement of teaching methods and the academic performance of students.

Table 2. Database searches

DATABASE	SEARCH EQUATION	YEAR								ARTICLES
		2014	2015	2016	2017	2018	2019	2020	2021	
Google Academic	Factors affecting academic performance	97	154	161	184	209	233	236	77	1.351
	Evaluation of higher education	43	19	32	11	7	21	13	92	238
	Industrial engineering knowledge	7	12	18	18	17	22	15	14	123
Science Direct	Factors affecting academic performance	-	4	-	2	1	2	-	1	10
	Evaluation of higher education	43	57	31	11	11	19	19	13	204
	Industrial engineering knowledge	-	-	1	1	-	15	1	-	18
Springer Link	Factors affecting academic performance	85	90	88	107	119	113	137	141	880
	Evaluation of higher education	21	14	14	17	14	39	35	28	182
SciELO	Factors affecting academic performance	-	1	1	3	1	4	5	1	16
	University knowledge tests	-	7	14	9	15	18	30	6	99
Scopus	Factors affecting academic performance	4	4	4	8	10	19	17	9	40
	Industrial engineering knowledge	43	62	79	90	111	154	116	47	319
	Evaluation of higher education	30	35	47	76	88	145	139	45	421
	University knowledge tests	12	13	18	17	28	39	46	16	114

Source: Authors' research (2021)

Continuing with the bibliographic review in the databases, we proceeded to analyze the information of each document, to select the most useful for research. In this order of ideas, criteria were defined for the object of study such as; keywords, year of publication, area of study, type of journal among others. From this, the number of articles to work with was determined as shown in the following flowchart:

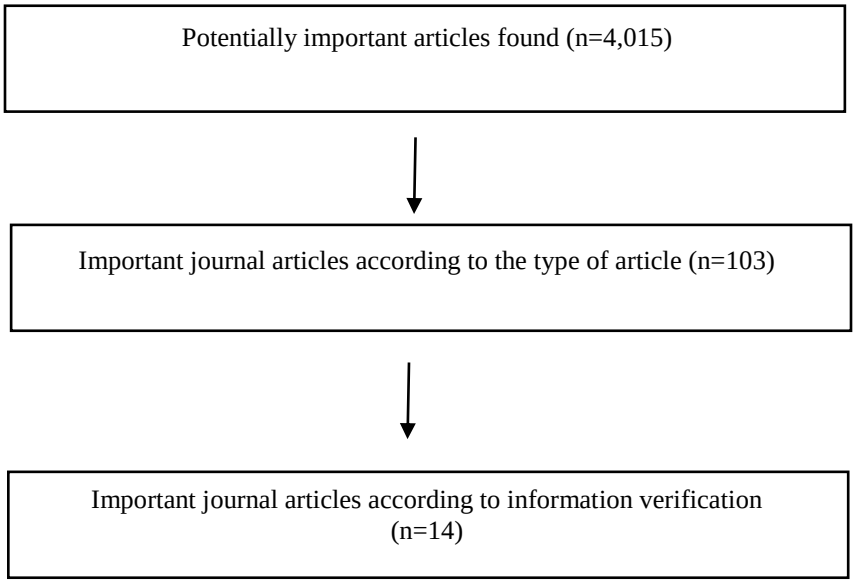


Fig. 2. Flowchart of analysis of filtered articles in bibliographic review

Source: Authors' research (2021)

III. RESULTS

The figure 2 shows the number of publications that were made in the databases in the period between 2014 to 2021 years in which the trends of the investigations of the relationship of academic performance with the results of the knowledge tests are analyzed. The figure shows that the maximum value obtained was in 2019 in the Scopus database, with a total of 357 publications made, at the lowest value, it was presented in the SciELO database this year, with a total of 7 publications found.

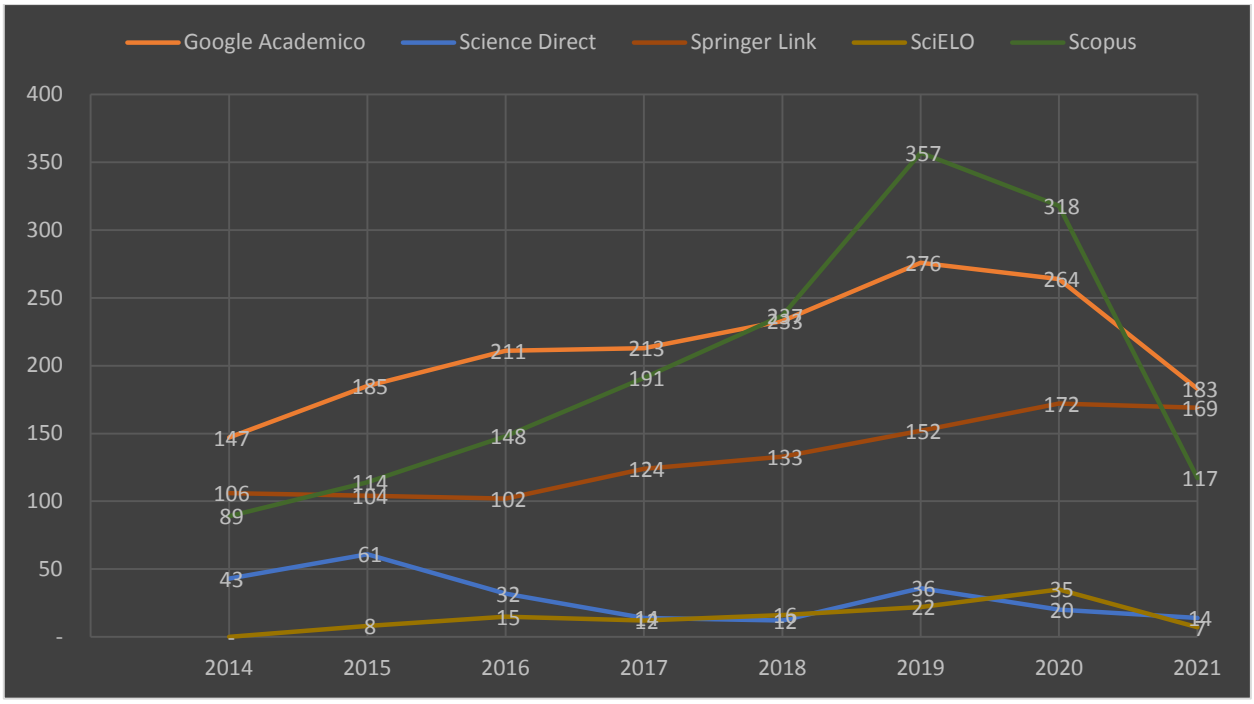


Fig. 2. Publications in years of research

Source: Authors' research (2021)

On the other hand, the most relevant articles with which we will work in the development of the research were analyzed, covering a total of 14 publications, considering the parameters established in the methodology. In Table 3 you can see the classification of each one, having as categories: Author, country, main results.

Table 3. Classification of Articles

Author(s)	Country	Main results
[5] Ganefri, Hendra Hidayat, Asmar Yulastri, Surfa Yondri (2019)	Indonesia	Academic training remains focused on theoretical activities and lacks the implementation of practical activities
[6] Faiz Zulkifli, Zulkifley Mohamed, Nor Afzalina Azmee (2019)	Malaysia	The predictive model of students' academic performance should consider the changes occurring in the current educational system that also prioritize the achievement of soft skills, interpersonal skills, and high-level thinking skills.
[7] K. Kirillova, O.P. Denisova, Z. V. Smirnova, O.I. Vaganova, M.N. Bulaeva, S.N. Kaznacheeva, E.A. Chelnokova (2019)	Russia	The control and evaluation activity of the higher education teacher is an integral component in the holistic educational process, whose key objective is the ability to monitor, analyze and evaluate the quality of the mastery of students of specific educational disciplines, modules, practical training.
[8] Fadzilah Siraj, Nur Azzah Abu Bakar (2019)	Malaysia	This study also investigates how correlation values and logistic regression variables mean the impact on academic performance.
[9] Mario José Martín Pavón, Dora Esperanza Santo Sevilla, Cristina Jenaro Río (2018)	Mexico	Highlights the importance of study habits as predictors of academic performance; that is, the ease with which these can be improved by educational institutions through curricular interventions.
[10] Malena Manchado Porras, Federico Hervías Ortega (2021)	Argentina	The psychological and psych pedagogical care services offered by different universities intervene in various factors that reduce academic performance. This type of service works with students in skills such as self-control and relaxation, self-esteem, organization, and time management, etc. The acquisition of these skills has a preventive effect against academic difficulties.
[11] Mesmin Destin, Ryan C. Svoboda (2018)	EE.UU.	When students are reminded of their own future identities focused on broader goals for success and well-being, financial costs become less detrimental and students are more likely to reap the benefits of an investment in education, regardless of socioeconomic background.
[12] Rubén Fraile, Francisco Bosch-Morell (2015)	Spain	The proposed scheme assumes that the performance of each teacher is a random variable whose distribution must be estimated using the evaluation notes of the students corresponding to that teacher.
[13] Josipa Roksa, Teniell L. Trolian, Charles Blaich, Kathleen Wise (2016)	EE.UU.	Gaps based on the constructivist theory of learning to identify several potential mechanisms that may explain the relationship between clear and organized instruction and students' academic performance
[14] Fan and Wan (2020)	China	Higher education is the main method of senior human resource development.

Source: Authors' research (2021)

According to the information provided by the table above, it can be deduced that the subject of study is relevant in various countries, such as the United States, Russia, China, Spain and Malaysia, appearing in the search Latin American countries, such as Mexico and Argentina, which focus on providing quality education. Based on scientific publications Latin American countries, become the indispensable bibliographic background to theoretically support the state of the art of this research, allowing optimal results for the topic to be developed in this research.

Reliability analysis (Cronbach's Alpha – SPSS)

The reliability of the instruments was determined according to the structure of the same, estimating the reliability of the instruments using the Alpha Cronbach formula,and using the statistical analysis software SPSS V20, the results are shown in Tables 4 and Table 5 were obtained.

Table 4. Summary of case processing

			N	%	
	Cases	Valid	62	100,0	
		Excluded [a]	0	,0	
		Total	62	100,0	
a.	b. List deletion based on all procedure variables.				

Source: Authors' research (2021), SPSS V20

Table 5. Reliability statistics

Cronbach´s Alfa	Elements #
,969	74

Source: Authors' research (2021)

According to [15] the reliability analysis of the applied instrument, using a sample of (62) individuals, shows a Cronbach's Alpha coefficient of 0.969 close to 1. Indicating that the items are consistent with each other, and the instrument is extremely reliable.

Continuing with the analysis of results, it was necessary to create a Scale of measurement of results, based on the number of questions contained per variable in the instrument applied and the values stipulated in the Likert scale.

Table 6. Relationship for measuring the variable Academic performance (Number of questions= 50)

Explanation calculation of maximum scores Variable 1			
If respondents choose only option 1	The maximum value would be	1X50	50
If respondents choose only option 2	The maximum value would be	2x50	100
If respondents choose only option 3	The maximum value would be	3x50	150
If respondents choose only option 4	The maximum value would be	4x50	200
If respondents choose only option 5	The maximum value would be	5x50	250

Source: Authors' research (2021)

According to the results obtained in Table 6, where a procedure is performed to multiply each item of the Likert scale with the maximum number of questions applied in the instrument concerning the variable of Academic Performance, the following scale was designed:

Table 7. The scale of Measurement results

Minimum Score	Maximum Score	Likert scale
1	50	1. Totally agree
51	100	2. I agree
101	150	3. Neither agree nor disagree
151	200	4. Disagreeing
201	250	5. Strongly disagree

Source: Authors' research (2021)

Next, the frequency and average results are obtained through the SPSS software with the results obtained in the application of the instrument

Table 8. Statistical

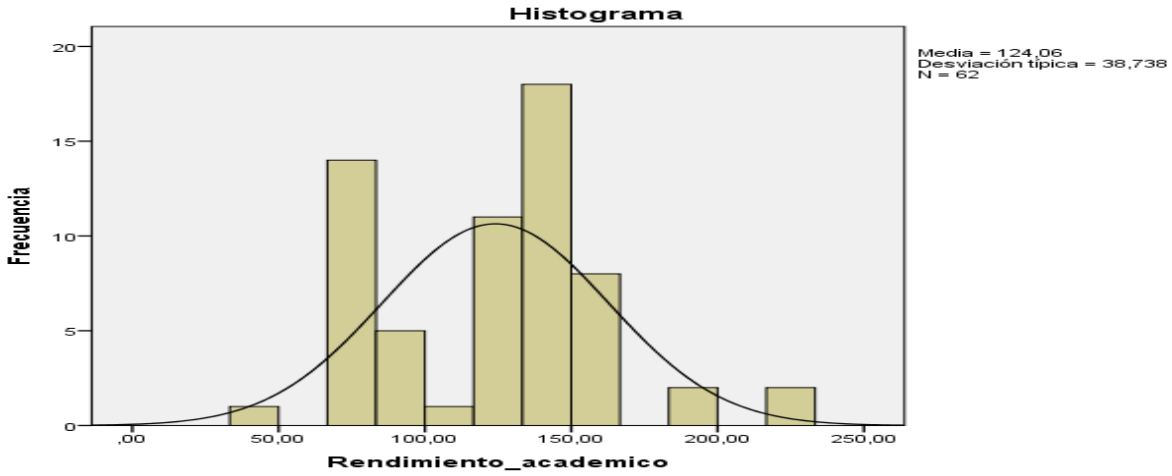
Variable Academic Performance

N	Valid	62
	Lost	0
Media		124,0645
Standard deviation		38,73782

Source: Authors' research (2021), SPSS V20

It can be observed that the average of the results obtained in the application of the instrument is 124.0645, which places the results in the range of Neither agree nor disagree, showing that the (62) students have little clarity in the factors that affect academic performance in the development of their career, showing the results in the histogram of Figure 3.

Fig. 3. Mean Histogram and Standard Deviation Results Academic Performance of Application Instrument



Source: Authors' research (2021), SPSS V20

Table 9. The ratio for measuring the SaberPro variable
Number of questions= 24

Explanation calculation of maximum scores Variable 1			
If respondents choose only option 1	The maximum value would be	1X24	24
If respondents choose only option 2	The maximum value would be	2x24	48
If respondents choose only option 3	The maximum value would be	3x24	72
If respondents choose only option 4	The maximum value would be	4x24	96
If respondents choose only option 5	The maximum value would be	5x24	120

Source: Authors' research (2021)

According to the results obtained in Table 9, where a procedure is performed to multiply each item of the Likert scale with the maximum number of questions applied in the instrument for the Saber Pro variable, the following scale was designed:

Table 10. The scale of Measurement of results

Minimum Score	Maximum Score	Likert scale
1	24	1. Totally agree
25	48	2. I agree
49	72	3. Neither agree nor disagree
73	96	4. Disagreeing
97	120	5. Strongly disagree

Source: Authors' research (2021)

Next, the frequency and average results are obtained through the SPSS software with the results obtained in the application of the instrument

Table 11. Statistical

Variable Tests SaberPro

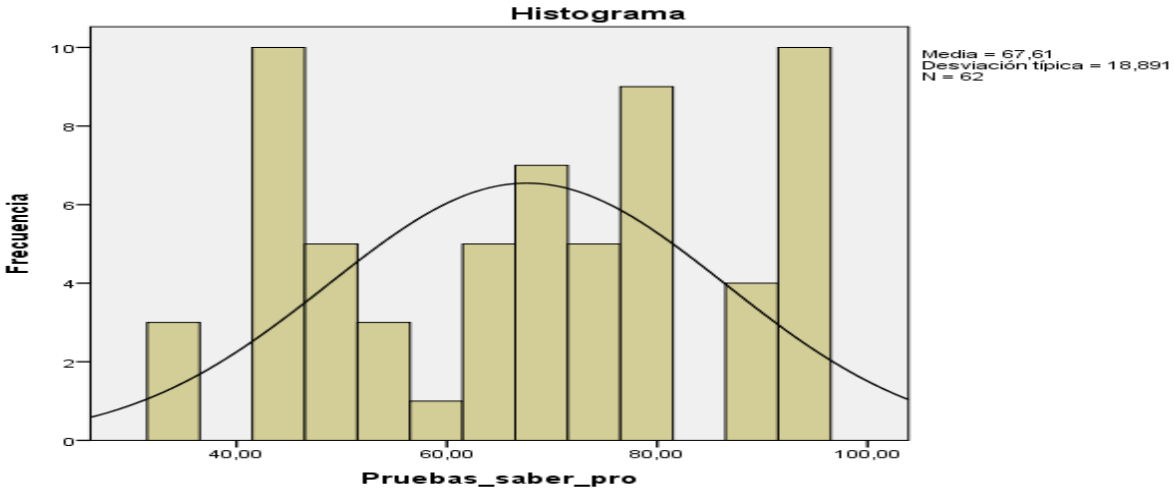
N	Valid	62
	Lost	0
Media		67,6129
Standard deviation		18,89085

Source: Authors' own research (2021), SPSS V20

It can be observed that the average of the results obtained in the application of the instrument is 67.6129, which places the results in the range of Neither agree nor disagree, showing that the (62) students have little clarity in the factors that affect the SaberPro tests in the development of their career, showing the results in the histogram in figure 4.

Figure 4. Mean Histogram and Standard Deviation Results Academic Performance of Application Instrument

The correlation between the two variables was then found using a software:



Source: Authors' research (2021)

The correlation between the two variables was then found using a software:

Table 12. Analysis of Correlations between Variables Academic Performance and Saber Pro Tests

		Academic performance	Saber Pro Test
Academic Performance	Pearson correlation	1	,281*
	Sig. (bilateral)		,027
	Sum of squares and products Cross	91537,742	12532,548
	Covariance	1500,619	205,452
	N	62	62

Source: Authors' research (2021)

*. The correlation is significant at level 0.05 (bilateral).

According to (Hernández et al. 2014), he recommends the values to measure the correlation between variables:
0.90 = Very strong negative correlation.
−0.75 = Considerable negative correlation.
−0.50 = Mean negative correlation.
−0.25 = Weak negative correlation.
−0.10 = Very weak negative correlation.
0.00 = There is no correlation between the variables.
+0.10 = Very weak positive correlation.
+0.25 = Weak positive correlation.
+0.50 = Mean positive correlation.
+0.75 = Considerable positive correlation.
+0.90 = Very strong positive correlation.
+1.00 = Perfect positive correlation ("A major X, major Y" or "a less X, less Y", proportionally. Each time X increases, Y always increases by a constant amount.)

For this case, it is shown that the Pearson correlation gave (0.281), placing in the range of more than 0.25, remaining in the group of weak positive correlation, which means that the variables academic performance and tests know pro are hardly related, both variables move in the same direction.
In addition, it has a significance of (0.027), following with [15], if this is less than the value 0.05, it is said that the coefficient is significant at the level of 0.05 (95% confidence that the correlation is true and 5% probability of error). that is, in this case, the confidence level would have an error of 2.7%; revealing that the risk of concluding that there is a correlation, when in fact it is not, is 2.7%.

IV. DISCUSSION

The fact that number of publications made in the databases for the period 2014 - 2021, its maximum value occurred in 2019 in Scopus (357), while Scielo (7) database, represents the lowest figure in 2021, show the research trends with academic performance variables and knowledge test results; This is a consequence of the Covid 19 pandemic, which also affected the dynamics of studies of this problems. However, the subject of study is great pre-eminence in countries that are interested in quality education since they know that education plays a decisive role in the growth and productivity of a country, and also the scientific publications support the state of the art of our investigation.
The instrument applied in the investigation declares a consistency between items since the reliability analysis reflects a Cronbach's Alpha coefficient of 0.969, which ensures a highly reliable instrument, consolidating the rigor of the investigation that according to theorists such as [15] validate our inferences, deducing that students have little clarity on the factors that affect academic performance and the results of the Saber Pro tests in the development of their career. was perceived in our study context because the application of the test is only a legal requirement for purposes of the graduation process in the undergraduate training and no penalty is established in case of poor results in the performance of the tests.
The Pearson correlation obtained (0.281), is located in the weak positive correlation group, which means that the variables academic performance and saber pro, tests are barely related; both variables move in the same direction. This confirms that there is a divorce between the way learning processes are evaluated in the classroom and the evaluation model applied by the external evaluator [1].
The significance of (0.027), allows us to affirm that the coefficient is significant at the 0.05 level, providing 95% confidence that the correlation is true and 5% probability of error, therefore, the confidence level would have an error of 2.7%; revealing that the risk of concluding that there is a correlation, when in fact there is not, is 2.7%.

This research will have an impact on improving the quality of the training processes of industrial engineering students because allows us to formulate strategies based on a logical framework methodology, which will be implemented immediately if solid arguments are raised before the academic and administrative instances. of the higher education institution with decision-making power.
For the immediate future, the problem must continue to be studied and successful experiences shared so that they can be applied institutionally in all academic programs that seek to improve their indicators of educational quality.

V. CONCLUSION

1. When examining the articles obtained from the period 2014 – 20121, an increase in the number of publications hosted by the different journals in the databases, Google Scholar, Science Direct, Springer Link, SciELO and Scopus is observed, taking into account that after 2014 an increase in publications in the databases can be found regarding the investigation of the relationship of academic performance with the results of the tests of knowledge in higher education students, specifically in industrial engineering students, adding a total of 4692 articles, determining that the Google Scholar database has 36% of the publication of the articles found, becoming the main window of international visibility.
2. It was possible to identify that the largest number of scientific publications, reviews and visualizations have been carried out in countries in Europe and Asia, in which exhaustive research is carried out concerning higher education and student performance, demonstrating the lack of national publications of scientific articles in indexed journals and contrasting with the increase in the number of publications at the international level after 2014.
3. The analysis of Co-occurrences in the different publications of the keywords extracted by VOSviewer from the articles published in Scopus, and also their relationship or links in the formation of networks or clusters, reflect the high degree of alignment that the topic of research related to metadata such as the human being (911), education (891) and students (813) has, focusing on the improvement of academic performance and the final tests of baccalaureate, for different scopes and objectives embodied by the authors in their published articles, all focused on the search for the improvement of teaching methods and the academic performance of students.
4. In the focus of the analyzed documents, it is necessary for the identification of the factors that can affect the academic performance of higher education students and the application of various methods to improve academic results both in the classrooms and at the time of carrying out the relevant knowledge tests at the end of the university career, being able to select the published articles that have relevance to the topic of the research and how they have been developed in different countries.
5. The reliability analysis of the applied instrument showed a Cronbach's Alpha coefficient of 0.969, which indicates that the items are consistent with each other, and the instrument is highly reliable.
6. Pearson's correlation was in the range of weak positive correlation which means that the variables academic performance and SaberPro tests are hardly related, both variables move in the same direction.
7. A significance of 0.027 was obtained, indicating that the coefficient is significant at the level of 0.05, that is, in this case, the confidence level would have an error of 2.7%; revealing that the risk of concluding that there is a correlation, when in fact it is not, is 2.7%.

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