ECOSYSTEM FOR THE DEVELOPMENT OF RESEARCH SKILLS INTEGRATING ICT IN HIGH SCHOOL EDUCATION.

ARIEL ADOLFO RODRIGUEZ-HERNANDEZ [1], LINA YORMARY MARTINEZ DIAZ [2], JOSE ERIBERTO CIFUENTES MEDINA [3]

Universidad Pedagógica y Tecnológica de Colombia, Grupo TICA [1]

Universidad Pedagógica y Tecnológica de Colombia, Grupo TICA [2]

Universidad Pedagógica y Tecnológica de Colombia, Grupo SIEK [3]

ariel.rodriguez@uptc.edu.co[1]

lina.martinez1@uptc.edu.co [2]

joseeriberto.cifuentes@uptc.edu.co [3]

Abstract *– Developing investigative skills from the earliest stages of school life is a priority in the Colombian educational system. It is proposed that pedagogical strategies mediated by information and communication technologies (ICT) will favor the development of these competences. To determine the effect of a research teaching module on a digital platform, the scores obtained by secondary school students corresponding to the sixth, seventh, eighth and ninth grades were compared through a Pre-Posttest. The Chamilo digital learning platform was used for the acquisition of investigative skills. The teaching module was implemented by 162 students. It was found that in the Pretreatment 41% of the students correctly identified the research concepts. In contrast, in the Post treatment, after interacting with the digital platform and the classroom plans for each learning session, 96% of the students correctly identified the research concepts. The results show that the teaching module and the digital platform were effective to develop investigative competences. It is essential to promote research in the child and youth population in the teaching-learning process to promote a citizen culture of science, technology and innovation (CTeI) that aims to build an environment based on the progress and use of knowledge.*

Keywords*: Research skills, digital literacy in research, research using technology, education in research, digital platform, pedagogical strategy using technology, ICT and research.*

Table of Contents

INTRODUCTION

Information and Communication Technologies (ICT) provide researchers with the opportunity to create knowledge without being limited by physical presence (Martínez-López and Gualdrón-Pinto, 2018). The use of ICT in education represents a change in the teaching and learning process as it modifies interpersonal relationships, facilitates the dissemination and access to information, and enhances the way knowledge is generated (Trapero, 2009; Cruz-Rojas, Molina-Blandón, and Valdiri-Vinasco, 2019).

In technology-mediated learning, it is observed that ICT promote new educational strategies where the central role is played by the student, and the role of the teacher is less active in the teaching process (De la Torre and Domínguez, 2012; Niño-Vega et al., 2017). Digital literacy, along with the use of ICT, improves the educational environment for students, making it more personalized and focused on them and their progress in learning. ICT should be used as a resource and support in the learning of various curriculum areas and should be integrated for the acquisition and development of skills (Graells, 2013).

Colombia needs to link scientific research as a means for economic and social development (Paz-López, 2019). Therefore, the Ministry of Science and Technology promotes public policies to foster science, technology, and innovation (STI) through: the production of knowledge, capacity building in STI, and the promotion of the use of STI in society (Law No. 1951, 2019). Research creates new scenarios in education with the aim of seeking answers to the unknown and allowing students to experiment with different responses through research strategies inside and outside the classroom (Urueña-López, 2019; Rodríguez and Morrison, 2019). This can internally motivate the generation of cognitive conflict, the search and management of information regarding the problem posed, as well as the formulation of hypotheses, data processing, and the management of variables that may arise in research (Inga Arias, 2014).

There are three key competencies to help students develop research skills: what (knowing), how (knowing how), and why (being) (Delgado, 2012; Romero de Monfrino, 2019). In the first case, if the student identifies a problem in their environment, they develop the competence of knowing. Second, if the student solves a problem and puts their knowledge into practice, they develop the competence of knowing how (López, 2010). Lastly, if the student has the ability to overcome obstacles, recognize errors, discover their potentialities and abilities that lead to personal growth, they develop the competence of being (Pérez, 2012).

Rojas (2007) considers the following as research competencies: Basic competencies assess inquiry, confrontation, contextualization, conjecture, hypothesis formulation, and questioning. Observation and Perception competencies assess sensitivity to phenomena, intuition, description, and the establishment of characteristics among objects, events, or phenomena from different contexts. The Thinking competency assesses analytical, reflective, critical, and logical thinking. Textual and Discursive competencies assess the ability to interpret texts; analyze the coherence of written texts; infer, communicate, and socialize results orally and in writing; argue and defend conceptual positions; and identify intentions in different types of narrative, explanatory, argumentative, and informative texts. Social competencies assess teamwork, and Methodological competencies assess the design of instruments, information retrieval or generation, methodology design, and techniques for organizing, systematizing, and analyzing information. These competencies can be developed by different participants, making their learning meaningful as it involves questioning, reflection, and the construction of new environments from their education (George Reyes and Salado Rodríguez, 2019).

The purpose of this research was to develop research competencies in high school students through ICT to promote the socio-cultural development of science, technology, and innovation in a group of students. For this, a research teaching module was designed, implemented, and validated on a digital learning platform, and it was analyzed whether the target population acquired these research competencies.

1. General objetive

The general objective was to develop research competencies in high school students by implementing ICT through a digital learning platform to promote their socio-cultural development in research.

2. Methodology

Their research approach was mixed, aimed at directly observing the research skills of students in the development of a research module that integrated a digital learning platform and face-to-face classroom to determine the role of ICT in their development. Information collection in the quantitative approach was achieved through a Pre-Post treatment, which was evaluated on a scale ranging from 1.0 to 100, and qualitative information in the qualitative approach was obtained through the level of performance achieved in the test. The study population was comprised of elementary, middle, and high school students from the educational institution Colegio Andrés Rosillo in Bogotá, where the sample included 162 students from the sixth, seventh, eighth, and ninth grades.

The study aimed to achieve the competencies proposed by Rojas (2007) and gradually develop these skills in students by integrating basic, observation and perception, thinking, textual and discursive, social, and methodological competencies. Specifically, developing these competencies involved selecting a research topic, analyzing and developing a research topic, formulating research objectives, writing a scientific text, searching and collecting information, structuring research work, and its dissemination.

The methodology for developing the research skills module was structured into four interrelated phases. The diagnostic phase assessed the level of performance of research competencies characteristic of the study population. The development phase focused on designing the means for improving research skills. In the application phase, the development of research competencies was sought. Finally, the assessment phase evaluated the level of performance achieved. The proposed structure not only relied on conducting research by applying these skills but also on the practice, development, and consolidation of projects worked on through a collaborative digital environment. The teacher served as a guide and facilitator in the teaching-learning process and knowledge construction. Evaluation was ongoing for

personalized monitoring through the digital platform, allowing for individual and group performance measurement.

Two written tests, with data collection instruments, were taken into account. The Pre-treatment collected data about prior research-related concepts, and the Post-treatment assessed the reception, comprehension, and analysis of concepts learned and applied after the development of the research skills module on the digital platform. The pretest and post-test consisted of 14 percentage-based multiple-choice questions.

Both knowledge tests were personalized, voluntary, and evaluable. They were distributed digitally through the assessment tool in the Chamilo digital learning platform at the beginning and end of the research module. The normality of the quantitative test study was verified through the application of the Shapiro-Wilk normality test and the non-parametric Wilcoxon rank-sum test, with a 95% confidence level for the statistical results, indicating a normal distribution of the obtained data. The structure of the two Pre-Post knowledge tests was validated by experts in the field (López-Roldán and Fachelli, 2015). Academic performance data were also considered, and data analysis was conducted to gain a deeper understanding of the research conducted.

3. Results

The descriptive and inferential statistical analysis between the Pre-Post treatment, conducted with the 162 high school students from the educational institution, is presented along with the satisfaction survey to validate if the objectives set for the research teaching module integrated into a digital learning platform were achieved.

3.1 Knowledge Tests

To measure the level of performance achieved by students regarding the development of research competencies, two knowledge tests, Pre and Post, were designed. The Pre-test aims to assess the existing concepts about research and the competencies to be evaluated. The Post-test evaluates the reception, comprehension, and analysis of the concepts learned and applied after the implementation of the research module through the digital platform to determine the level of performance achieved by students.

3.2 Pre-Treatment Results

To establish the initial concepts of students regarding knowledge related to research and research skills, an initial test focused on assessing the performance of the previously mentioned research competencies was implemented. Below, Table 1 displays the results obtained by students from sixth to ninth grades in the initial test.

The table 1 illustrates the results obtained by students in the initial test for each grade. It can be observed that for the sixth grade, only 40.95% of students passed the initial test, while 59.05% failed. In the seventh grade, 45.95% of students passed, and 54.05% failed the initial test. For the eighth grade, only 40.84% of students passed, while 59.16% failed the initial test. Finally, for the ninth grade, only 32.48% of students passed, and 67.52% failed. Additionally, this grade had a higher percentage of students who failed the initial test.

Table 1. Percentage assessment of the level of research competencies in the initial test

Competencies	Performance			
	Low	Basic	High	Superior
Six Grade				
Basic	60,86	26,09	10,87	2,18
Observation and perception	65,21	23,92	8,69	2,18
Thinking	54,34	39,13	4,35	2,18
Textual and discursive	58,69	36,95	2,18	2,18
Social	54,34	28,27	13,05	4,34
Methodological	60,86	28,27	8,69	2,18
Seven Grade				
Basic	54,05	35,13	8,11	2,71
Observation and perception	45,94	40,54	8,11	5,41

Thinking	48,64	35,13	10,82	5,41
Textual and discursive	72,97	13,51	8,11	5,41
Social	48,64	32,43	10,82	8,11
Methodological	54,05	24,33	13,51	8,11
Eighth Grade				
Basic	65	25	7,5	2,5
Observation and perception	50	37,5	10	2,5
Thinking	57,5	35	5	2,5
Textual and discursive	55	32,5	10	2,5
Social	62,5	22,5	12,5	2,5
Methodological	65	22,5	10	2,5
Ninth Grade				
Basic	69,23	23,08	5,13	2,56
Observation and perception	79,48	12,83	5,13	2,56
Thinking	58,98	30,77	7,69	2,56
Textual and discursive	69,23	20,52	7,69	2,56
Social	69,23	17,95	5,13	7,69
Methodological	58,98	33,33	5,13	2,56

Source: Author's own work

The table 2 displays the measures of central tendency and dispersion for the scores obtained in the initial test by the students in basic secondary education, thus identifying the entry level for research competencies. The measures of central tendency and dispersion for the scores obtained by the students in the Pre-treatment show that 50% of the students have scores below 63.5. Furthermore, 75% of the students have scores below 78.25, indicating that their performance in the test is low and basic for research competencies.

Table 2. Measures of central tendency and dispersion obtained in the initial test.

Mean	sd	IQR	cv	Skewness	Kurtosis	Quantiles			n
						25%	50%	75%	
60,950	19,780	32,5	0,3245	-0,3237	-1,0729	45,75	63,5	78,25	162

Source: Author's own work

The table 3 presents the measures of central tendency for each of the competencies evaluated in the Pre-treatment. It is evident that a significant portion of the students are at a low and basic performance level. Additionally, the competence with the most difficulty is textual and discursive, as approximately 50% of the students have scores below 58, indicating a low level, while a small percentage of students achieved a basic performance.

In the basic competencies, 75% of the students have scores below 78, indicating a basic performance level. In the methodological competencies, it is observed that approximately 75% of the students have scores below 79, indicating both low and basic performance, in contrast to the 25% who passed with scores above 79. In the observation and perception competence, about 50% of the students have scores below 66, indicating a low performance level, while 25% with scores above 79.25 achieved a basic performance level. In the social competencies, approximately 75% of the students have scores below 79.25, indicating a basic level. In the thinking competence, 50% of the students have scores below 68.5, signifying a low performance level, in contrast to 25% with scores above 80, who passed with a basic performance level.

The results obtained by the students in the initial test reveal deficiencies in the development of research competencies, justifying the implementation of a training module.

Table 3. Measures of central tendency and dispersion for each competency evaluated in the initial test.

Competencies	Mean	sd	IQR	cv	Skewness	Kurtosis	Quantiles			n
							25%	50%	75%	
Basic	53,969	25,086	45,25	0,4648	-0,069	-1,2713	32,75	51	78	162

Observation and perception	60,858	22,190	40,5	0,3646	-0,2354	-1,2859	38,75	66	79,25	162
Thinking	63,876	20,464	30	0,3203	-0,561	-0,7574	50	68,5	80	162
Textual and discursive	55,666	23,128	42	0,4154	-0,1084	-1,1932	35	58	77	162
Social	62,487	21,925	34,5	0,3508	-0,34	-1,0488	44,75	66,5	79,25	162
Methodological	57,697	24,539	46,5	0,4253	-0,235	-1,343	32,5	64	79	162

Source: Author's Own

3.3 Didactic design

The didactic design of the module is illustrated in Figure 1. The design involves the integration of the digital learning platform and the proposed pedagogical strategy, starting from the students' prior concepts, applying constructivism and meaningful learning in the classroom, and the role of the teacher as a mediator and guide in the teaching-learning process and as a motivator for knowledge construction.

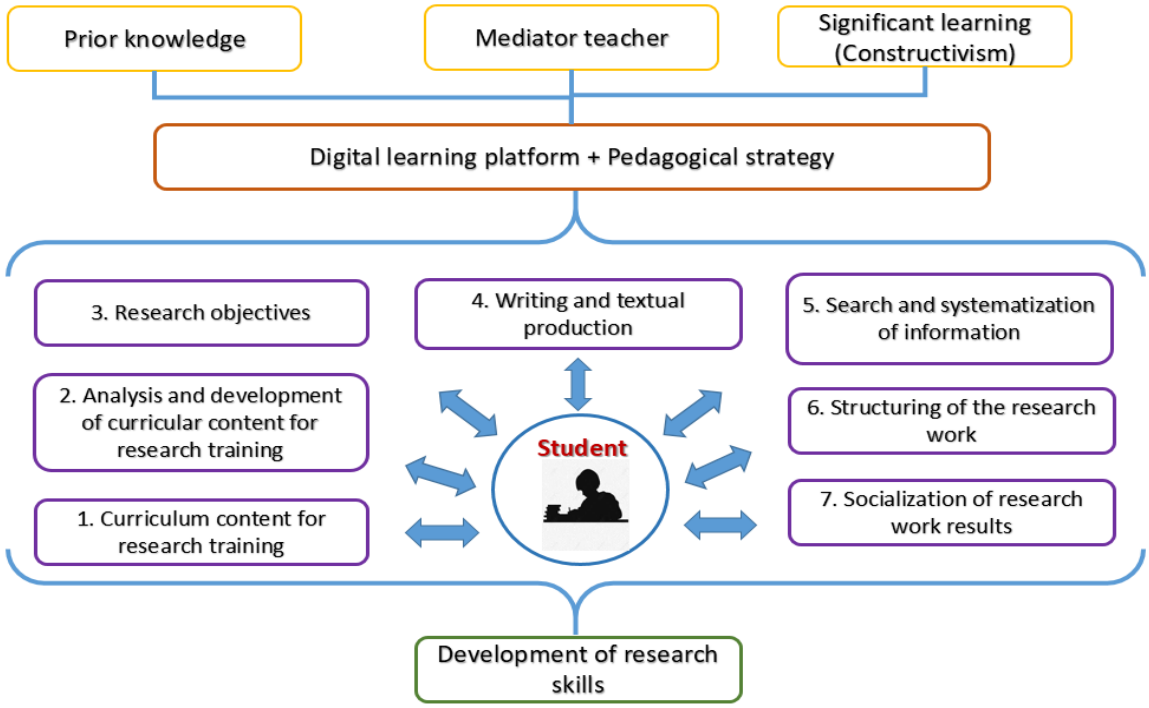

Figure 1. Didactic Design. Source: Author's Own

For interaction with the digital learning platform, activities were designed such as quizzes, forums, chat, tasks, wikis, and collaboration in blogs. These activities promote collaborative knowledge construction with both synchronous and asynchronous forms of communication, aiming to achieve interpersonal communication (Navarro-Pablo, López-Gándara, and García-Jiménez, 2019). They aim to develop research skills and complement the knowledge acquired through practice, application, and the completion of proposed activities (De Pablos, Colás, López Gracia, and García-Lázaro, 2019).

Constructivism focuses on the student, who is responsible for connecting and constructing knowledge within a context of networks and groups (Hernández-Carranza, Romero-Corella, Ramírez-Montoya, 2015). This is achieved through the development of various practical activities on the digital platform, enabling students to engage in the research process from its inception, identifying a situation or problem in their environment, to its culmination with dissemination and defense. Additional activities help reinforce the acquisition of new knowledge.

3.4 Post-Treatment Results

To assess the concepts learned by students after interacting with the digital learning platform to develop research competencies, a final test was administered, and the results are presented in Table 4.

Table 4. Percentage assessment of research competency levels in the final test

Competencies	Performance			
	Low	Basic	High	Superior
Six Grade				
Basic	4,34	10,88	58,69	26,09
Observation and perception	2,18	13,04	52,17	32,61
Thinking	4,34	6,53	54,35	34,78
Textual and discursive	8,69	13,04	45,66	32,61
Social	2,18	13,04	39,13	45,65
Methodological	2,18	8,69	52,17	36,96
Seven Grade				
Basic	2,7	5,4	51,36	40,54
Observation and perception	5,4	13,52	43,25	37,83
Thinking	2,7	8,11	56,75	32,44
Textual and discursive	2,7	10,81	62,17	24,32
Social	2,7	5,4	43,25	48,65
Methodological	2,7	5,4	51,36	40,54
Eighth Grade				
Basic	5	10	57,5	27,5
Observation and perception	2,5	15	47,5	35
Thinking	2,5	12,5	45	40
Textual and discursive	2,5	7,5	57,5	32,5
Social	2,5	12,5	65	20
Methodological	5	12,5	45	37,5
Ninth Grade				
Basic	7,69	12,82	46,15	33,33
Observation and perception	2,56	10,26	38,46	48,72
Thinking	5,13	10,26	38,46	46,15
Textual and discursive	2,56	7,69	38,46	51,29
Social	2,56	5,13	53,85	38,46
Methodological	2,56	12,82	48,72	35,90

Source: Author's Own

In Table 4, it can be observed that approximately 96.02% of the sixth-grade students passed, with only 3.98% failing the final test. For the seventh grade, 96.85% of the students passed, while only 3.15% failed the final questionnaire. In the eighth grade, approximately 96.6% of students passed, in contrast to 3.34% who did not. Finally, for the ninth grade, 96.15% of students passed, with only 3.85% failing the final test.

Next, an analysis of the measures of central tendency and dispersion for the scores obtained by students in the final test, after completing the research module and interacting with the digital learning platform to develop research competencies, is presented.

Table 5. Measures of central tendency and dispersion obtained in the final test

Mean	sd	IQR	cv	Skewness	Kurtosis	Quantiles			n
						25%	50%	75%	
88,870	6,722	8	0,07564	-0,9462	0,3984	86	90	94	162

Source: Author's Own

The table 5 presents the measures of central tendency and dispersion for the scores obtained by students in the Post-treatment. It shows an average score of 88.8, and their performance improved compared to the initial test. Furthermore, it is observed that more than 50% of the students passed with scores above 75, 25% achieved scores above 80, falling within a range of scores from 86 to 94. This indicates an improvement in research competencies compared to the results obtained in the initial test.

Table 6. Measures of central tendency and dispersion for each competency evaluated in the final test

Competencies	Mean	sd	IQR	cv	Skewness	Kurtosis	Quantiles			n
							25%	50%	75%	
Basic	89,092	6,610	8	0,0741	-1,067	1,0117	86	90	94	162
Observation and perception	84,475	4,840	7	0,0573	-0,7963	0,8281	82	85	89	162
Thinking	88,808	6,399	7	0,0720	-1,0023	0,939	86	89	93	162
Textual and discursive	83,765	4,897	6	0,0584	-0,9092	1,0365	82	84	88	162
Social	89,043	5,893	9	0,0661	-0,6748	0,0656	85	89	94	162
Methodological	88,543	6,273	8	0,0708	-0,8831	0,9894	85	89	93	162

Source: Author's Own

In the table 6 displays the measures of central tendency and dispersion for the competencies evaluated in the Post-treatment. It is evident that the average score for all six competencies increased. The highest results were achieved in basic and social competencies, as more than 75% of the students passed with scores ranging from 89 to 94. In the thinking and methodological competencies, more than 50% of the students passed with scores between 89 and 93. Additionally, in the textual-discursive and observation-perception competencies, more than 50% of the students passed. However, the highest score obtained in these two competencies is 88 and 89, respectively, indicating that none of the students managed to answer 100% of the questions related to these competencies.

3.5. Inferential Statistical Application - Comparison of Research Competencies Pre-Test / Post-Test

For the application of inferential statistical tests, the normality of each of the scores obtained in the research competencies before and after the implementation of the research teaching module on a digital platform is first verified. This involved applying the Shapiro-Wilk test to identify the results of the p-values, as shown in Table 7.

Table 7. Shapiro-Wilk Normality Test (P-Value)

Competencias	Antes	Después
Basic	2,03292e-06	1,43651e-07
Observation and perception	2,92422e-07	3,90381e-06
Thinking	5,59413e-07	4,78055e-07
Textual and discursive	6,86654e-06	3,08898e-07
Social	3,07902e-06	1,24605e-05
Methodological	1,05294e-07	8,78279e-06

Source: Author's Own

For the calculation of the Shapiro-Wilk test, a significance level of 5% ($\alpha = 0.05$) is used, where if the p-value is less than alpha, the null hypothesis is rejected, and it is concluded that the data does not come from a normal distribution. In this case, none of the p-values are greater than 0.05, so the hypothesis that the data is normally distributed is rejected.

The non-parametric Wilcoxon rank-sum test is applied, using a margin of error of 5% ($\alpha = 0.05$) and a confidence level of 95%, which is the equivalent of the t-test, where it was found that the data does not follow a normal distribution. The aim of this test is to determine whether there are significant differences in the academic performance of students in terms of basic research competencies, observation and perception, thinking, textual and discursive, social, and methodological competencies regarding the scores obtained by students before and after the implementation of the research teaching module on a digital platform.

Basic Competencies

Hypothesis

Ho: The scores obtained before the implementation (research teaching module on a digital platform) are equal to those obtained after the implementation in basic competencies.

Ha: The scores obtained before the implementation (research teaching module on a digital platform) are not equal to those obtained after the implementation in basic competencies.

Test Statistic:

V = 0

P-value = 9.57919e-07

Ho is rejected since p-value < α, which means 9.57919e-08 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by students before and after interacting with the research teaching module on a digital platform are not the same in basic competencies.

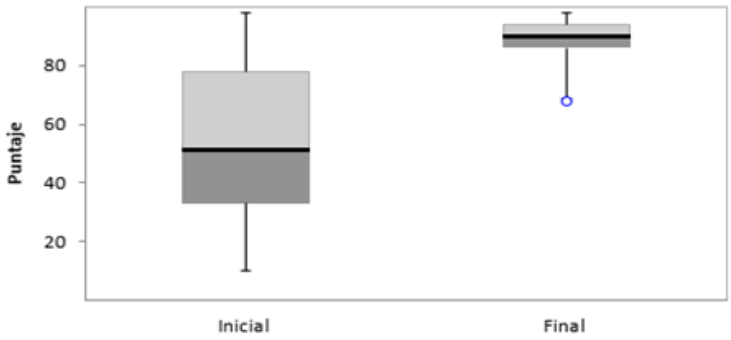

Figure 2. Academic Performance in Basic Competencies. Pre-test / Post-test
Source: Author's Own

Observation and Perception Competencies

Hypothesis

Ho: The scores obtained before the implementation (research teaching module on a digital platform) are equal to those obtained after the implementation in observation and perception competencies.

Ha: The scores obtained before the implementation (research teaching module on a digital platform) are not equal to those obtained after the implementation in observation and perception competencies.

Test Statistic:
V = 0
P-value = 1.01386e-07
Ho is rejected since p-value < α, which means 1.01386e-07 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by students before and after interacting with the research teaching module on a digital platform are not the same in observation and perception competencies.

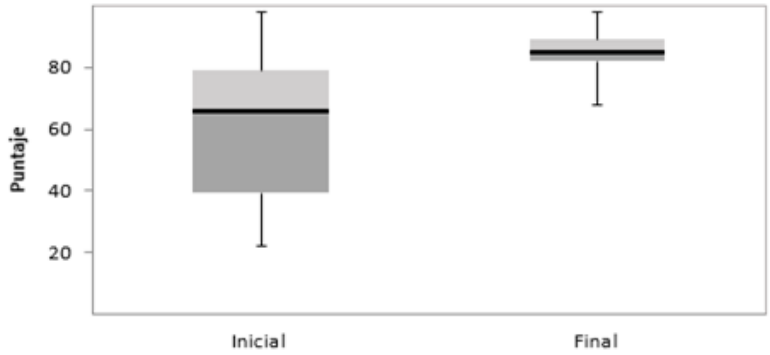

Figure 3. Academic Performance in Observation and Perception Competencies. Pre-test / Post-test
Source: Author's Own

Thinking Competencies

Hypothesis

Ho: The scores obtained before the implementation (research teaching module on a digital platform) are equal to those obtained after the implementation in thinking competencies.

Ha: The scores obtained before the implementation (research teaching module on a digital platform) are not equal to those obtained after the implementation in thinking competencies.

Test Statistic:
V = 0
P-value = 1.36846e-07

Ho is rejected since p-value < α, which means 1.36846e-07 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by students before and after interacting with the research teaching module on a digital platform are not the same in thinking competencies.

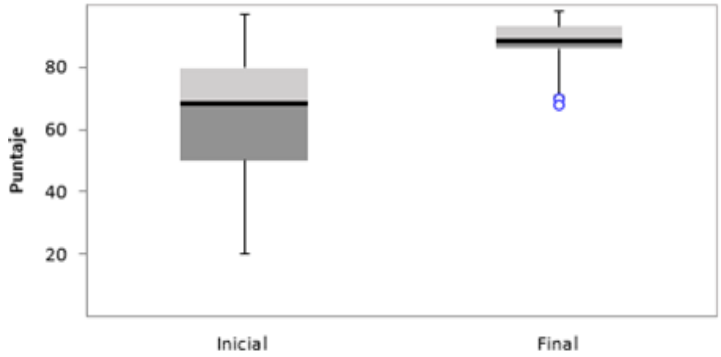

Figure 4. Academic Performance in Thinking Competencies. Pre-test / Post-test
Source: Author's Own

Textual and Discursive Competencies

Hypothesis

Ho: The scores obtained before the implementation (research teaching module on a digital platform) are equal to those obtained after the implementation in textual and discursive competencies.

Ha: The scores obtained before the implementation (research teaching module on a digital platform) are not equal to those obtained after the implementation in textual and discursive competencies.

Test Statistic:
V = 0
P-value = 5.33331e-07

Ho is rejected since p-value < α, which means 5.33331e-07 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by students before and after interacting with the research teaching module on a digital platform are not the same in textual and discursive competencies.

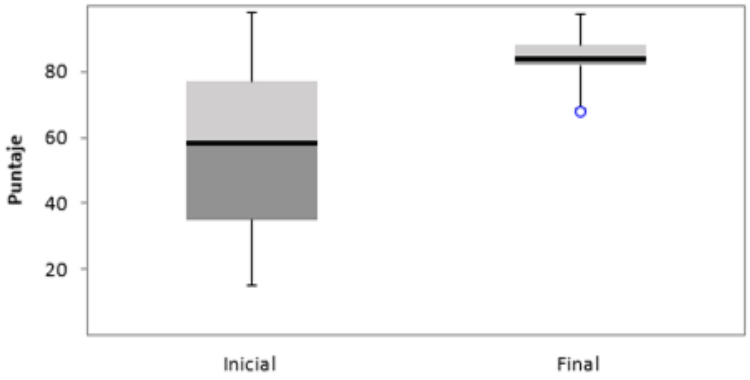

Figure 5. Academic Performance in Textual and Discursive Competencies. Pre-test / Post-test
Source: Author's Own

Social Competencies

Hypothesis

Ho: The scores obtained before the implementation (research teaching module on a digital platform) are equal to those obtained after the implementation in social competencies.

Ha: The scores obtained before the implementation (research teaching module on a digital platform) are not equal to those obtained after the implementation in social competencies.

Test Statistic:
V = 0
P-value = 1.04003e-07

Ho is rejected since p-value < α, which means 1.04003e-07 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by students before and after interacting with the research teaching module on a digital platform are not the same in social competencies.

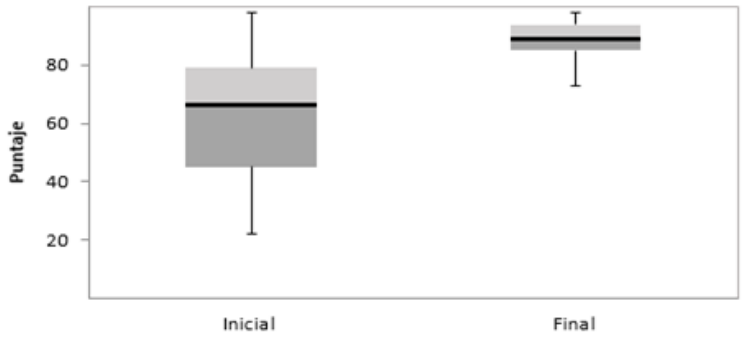

Figure 6. Academic Performance in Social Competencies. Pre-test / Post-test
Source: Author's Own

Methodological Competencies

Hypothesis

Ho: The scores obtained before the implementation (teaching module on research in a digital platform) are equal to those obtained after the implementation in methodological competencies.

Ha: The scores obtained before the implementation (teaching module on research in a digital platform) are not equal to those obtained after the implementation in methodological competencies.

Test Statistics
V = 0
P-value = 1.91584e-07

Ho is rejected because p-value < α, i.e., 1.91584e-07 < 0.05.

With a significance level of 5% and a confidence interval of 95%, it is determined that the scores obtained by the students before and after interacting with the research teaching module on a digital platform are not the same in methodological competencies.

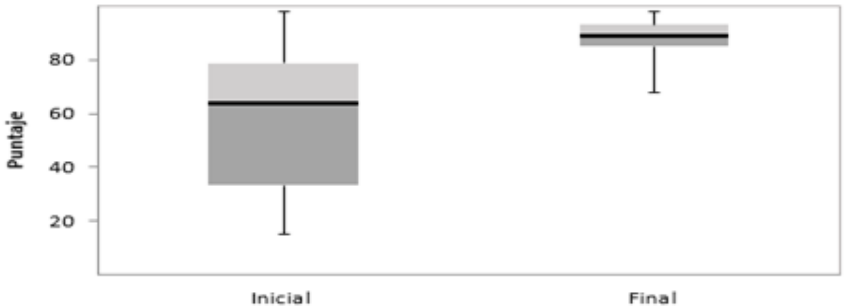

Figure 7. Academic Performance in Methodological Competencies. Pre-test/Post-test
Source: Author's Own

According to the statistical analysis performed on the performance levels achieved by students in the final and initial tests in the categories of basic competencies, observation and perception, thinking, textual and discursive skills, social skills, and methodological competencies, it can be stated that these research competencies improved due to the implementation of the research module and the digital learning platform with the target population. These data demonstrate the importance of promoting research from an early school stage because these learning mechanisms allow students to actively participate in their environment, set clear academic objectives, and project themselves into the research field, generating different contributions to their personal and professional development.

CONCLUSION

The goal was to advance the implementation of research from early stages of school life and its integration with the digital environment. This endeavor aimed to contribute to the strengthening of CTeI (Science, Technology, and Innovation) and the transformation of school practices, fostering the development of collaborative projects where ICTs (Information and Communication Technologies) become a channel for communication and information, ensuring open, interactive, stimulating, and information-rich learning environments that motivate students and focus on competency development (García-Valcárcel et al., 2014) for research in the child and youth population.

In the application of the digital learning platform, constructivism was employed, where, through the development of activities, students relate new concepts to prior ones. Thus, it can be observed that the implementation of a digital learning platform does not depend on a single pedagogical model, but rather any other model can be proposed. The critical factor for the success of the teaching-learning process lies in the ICT tools that teachers provide to their students for communication and interaction, social participation, and improved academic performance (Santoveña-Casal and Bernal-Bravo, 2019).

These findings are supported by a study conducted by Aguiar and Cuesta (2009), where ICTs were introduced into early childhood education through methods such as WEBQUEST and internet-based teaching-learning activities. The implementation of ICT from early childhood, rather than just in primary or secondary education, is crucial. Regarding the results of this research, it underscores the importance of ICT in the classroom and how they can be implemented at different educational stages, yielding positive outcomes when used correctly.

Hermosa Del vasto (2015) provides a review of the state of the art related to ICT and an overview of the perception of some teachers and students regarding the use of technological resources. In this regard, one essential aspect of this research is that the proper use of ICT, such as the integration of digital learning platforms in the classroom, maintains students' motivation to learn new knowledge. It emphasizes the need for all educational institutions in Colombia to implement these digital platforms.

The analysis of the results obtained in the initial and final tests shows that the level of performance significantly improved after the target population interacted with the digital learning platform. Students are more motivated to collaborate with others, and the opportunity to build together while interacting with others and the option to share resources is emphasized (Gutiérrez-Porlán et al., 2018). This suggests that this tool had a positive influence on the development of research competencies. This is supported by a study that found that the use of a content management platform to develop digital competencies influences education through the use of content management platforms as catalysts for competency development and promoting collaborative work in the classroom (Mezarina-Aguirre et al., 2014).

In conclusion, implementing a digital learning platform, educational materials, virtual learning objects, or virtual learning environments, along with other available digital resources, facilitates both the teacher's work in teaching topics and the acquisition of knowledge. The learning space of the students should be filled with tools, technologies, and social interaction practices capable of complementing and expanding the limits of human intelligence (Gee and Esteban-Guitart, 2019). This is supported by a study that highlights that the use of technological tools in the classroom significantly affects students' performance, exerting a positive influence when technology is used appropriately in the classroom and when teachers know which tools are suitable for their students. However, for educational materials mediated by ICT to have a positive impact when implemented in the classroom, the content must be adapted to the needs of the target population, rather than having the population adapt to the content (García-Martín and Cantón-Mayo, 2019).

REFERENCES

[1] Aguiar-Perera, M., & Cuesta-Suárez, H. (2009). Importancia de trabajar las TIC en educación infantil a través de Métodos como la Webquest. Pixel-Bit. Revista de Medios y Educación, (34), 81-94. http://bit.ly/32gbfsH

[2] Cruz-Rojas, G., Molina-Blandón, M., & Valdiri-Vinasco, V. (2019). Vigilancia tecnológica para la innovación educativa en el uso de bases de datos y plataformas de gestión de aprendizaje en la universidad del Valle, Colombia. Revista de Investigación, Desarrollo e Innovación, 9(2), 303-317. https://doi.org/10.19053/20278306.v9.n2.2019.9175

[3] *Delgado, M. H. (2012). Mejoramiento de la competencia investigativa en la formación de docentes de licenciatura en educación básica. (Doctoral dissertation, Tesis de Maestría]. Bogotá: Universidad Libre de Colombia). http://bit.ly/2Lb0n9K*

[4] *De la Torre Navarro, Lilia María, & Domínguez Gómez, José. (2012). Las TIC en el proceso de enseñanza aprendizaje a través de los objetos de aprendizaje. Revista Cubana de Informática Médica, 4(1), 83-92. http://bit.ly/2Pvq2hz*

[5] *De Pablos, J.M., Colás, M.P., López Gracia, A. y García-Lázaro, I. (2019). Uses of digital platforms in Higher Education from the perspectives of the educational research. REDU. Revista de Docencia Universitaria, 17(1), 59-72. https://doi.org/10.4995/redu.2019.11177*

[6] *García-Martín, S. & Cantón-Mayo, I. (2019). Use of technologies and academic performance in adolescent students. [Uso de tecnologías y rendimiento académico en estudiantes adolescentes]. Comunicar, 59, 73-81. https://doi.org/10.3916/C59-2019-07*

[7] *García-Valcárcel, A., Basilotta, V. & López, C. (2014). ICT in Collaborative Learning in the Classrooms of Primary and Secondary Education. [Las TIC en el aprendizaje colaborativo en el aula de Primaria y Secundaria]. Comunicar, 42, 65-74. https://doi.org/10.3916/C42-2014-06*

[8] *Gee, J. & Esteban-Guitart, M. (2019). Designing for deep learning in the context of digital and social media. [El diseño para el aprendizaje profundo en los medios de comunicación sociales y digitales]. Comunicar, 58, 9-18. https://doi.org/10.3916/C58-2019-01*

[9] *George Reyes, C., & Salado Rodríguez, L. (2019). Competencias investigativas con el uso de las TIC en estudiantes de doctorado. Apertura, 11(1), 40-55. http://dgx.doi.org/10.32870/Ap.v11n1.1387*

[10] *Graells, P. M. (2013). Impacto de las TIC en la educación: funciones y limitaciones. 3C TIC, 2(1). https://doi.org/10.17993/3ctic.2013.21.%20*

[11] *Gutiérrez-Porlán, I., Román-García, M. & Sánchez-Vera, M. (2018). Strategies for the communication and collaborative online work by university students. [Estrategias para la comunicación y el trabajo colaborativo en red de los estudiantes universitarios]. Comunicar, 54, 91-100. https://doi.org/10.3916/C54-2018-09*

[12] *Hermosa Del vasto, P., M. (2015). Influencia de las tecnologías de información y comunicación (TIC) en el proceso enseñanza-aprendizaje: una mejora de las competencias digitales. Rev. Cient. Gen. José María Córdova 13(16), 121-132. http://bit.ly/2HC8CJJ*

[13] *Hernández, E.E., Romero, S.I. & Ramírez-Montoya, M.S. (2015). Evaluation of Digital Didactic Skills in Massive Open Online Courses: a Contribution to the Latin American Movement. [Evaluación de competencias digitales didácticas en cursos masivos abiertos: Contribución al movimiento latinoamericano]. Comunicar, 44, 81-90. https://doi.org/10.3916/C44-2015-09*

[14] *Inga Arias, M., & Inga Arias, M. (2014). Estrategias para promover investigación en el aula. Investigación Educativa, 10(17), 51 - 65. http://bit.ly/2HBuepL*

[15] *Martínez-López, L., & Gualdrón-Pinto, E. (2018). Fortalecimiento del pensamiento variacional a través de una intervención mediada con TIC en estudiantes de grado noveno. Revista de Investigación, Desarrollo e Innovación, 9(1), 91-102. https://doi.org/10.19053/20278306.v9.n1.2018.8156*

[16] *Mezarina, C.A., Páez, H., Terán, O. & Toscano, R. (2014). Aplicación de las TIC en la educación superior como estrategia innovadora para el desarrollo de competencias digitales. Campus virtuales, 3(1), 88-101. http://bit.ly/2NJz1cu*

[17] *Navarro-Pablo, M., López-Gándara, Y. & García-Jiménez, E. (2019). The use of digital resources and materials In and outside the bilingual classroom. [El uso de los recursos y materiales digitales dentro y fuera del aula bilingüe]. Comunicar, 59, 83-93. https://doi.org/10.3916/C59-2019-08*

[18] *Niño-Vega, J. E., Martínez-Díaz, L. Y., Fernández-Morales, F. H., Duarte, J. E., Reyes-Caballero, F., & Gutiérrez-Barrios, G. J. (2017). Entorno de aprendizaje para la enseñanza de programación en Arduino mediado por una mano robótica didáctica. Revista Espacios, 38(60), 23. http://bit.ly/2UjEND3*

[19] *Ley No. 1951. Congreso de Colombia. Por la cual crea el ministerio de ciencia, tecnología e innovación, se fortalece el sistema nacional de ciencia, tecnología e innovación y se dictan otras disposiciones. Colombia. http://bit.ly/2LdB1Z5*

[20] *López- Gumucio, J. R. (2010). La selección del personal, basada en competencias y su relación con la eficacia organizacional. Perspectivas, (26), 129-152. http://bit.ly/2ZAvzqT*

[21] *López-Roldán, P., & Fachelli, S. (2015). Análisis de tablas de contingencia. En Metodología de la Investigación Social Cuantitativa. Bellaterra, Espanya: Universitat Autònoma de Barcelona. http://bit.ly/2ZH1Dtc*

[22] *Paz-López, M. (2019). Aportes sobre la cooperación científico-tecnológica entre Argentina y Colombia (2007-2015). Revista Ciencia Política, 14(27), 91-114. https://doi.org/10.15446/cp.v14n27.74137*

[23] *Pérez-Rocha, M. I. (2012). Fortalecimiento de las competencias investigativas en el contexto de la educación superior en Colombia. Revista de investigaciones UNAD, 11 (1), 10-34. https://doi.org/10.22490/25391887.770*

[24] Rodríguez, A. J., & Morrison, D. (2019). Expanding and enacting transformative meanings of equity, diversity and social justice in science education. Cultural Studies of Science Education, 14(2), 265-281. https://doi.org/10.1007/s11422-019-09938-7

[25] Rojas, Sandra P. (2007). El estado del arte como estrategia de formación en la investigación. Studiositas, Vol. 2 (3). http://bit.ly/2PvMJCo

[26] Romero de Monfrino, A. (2019). Gestión investigativa en la era del conocimiento. Cienciamatria, 5(9), 35-47. https://doi.org/10.35381/cm.v5i9.98

[27] Santoveña-Casal, S. & Bernal-Bravo, C. (2019). Exploring the influence of the teacher: Social participation on Twitter and academic perception. [Explorando la influencia del docente: Participación social en Twitter y percepción académica]. Comunicar, 58, 75-84. https://doi.org/10.3916/C58-2019-07

[28] Trapero, D. A. (2009). Importancia de las TIC en la Educación. Revista Digital Innovación y Experiencias Educativas, 4. http://bit.ly/34jNIcn

[29] Urueña-López, J. (2019). La investigación escolar para la vida: diseñando nuevas experiencias formativas. Emerging Trends in Education, 1(2). https://doi.org/10.19136/etie.a1n2.3260