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Teaching Science By Inquiry In The Curricular Area Of Science And Technology

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SUMMARY

For centuries, education was conceived as the unilateral transmission of knowledge between sender and receiver, the evaluation of which stamped a classifying stamp on the participants. However, the knowledge society of which we are a part, characterized by the leading role that knowledge obtained as a product of inquiry has assumed, which, as it is not observed in our classrooms, motivates the search for changes in the methodology of teaching, with the firm conviction that it results in the formation of critical individuals. autonomous, with the ability to solve problems in their environment, finding it necessary to influence the strengthening of scientific inquiry through the Inquire of Science and Technology competition, in order to train researchers from secondary school classrooms.

This reality motivated us to propose in this study, the application of the ECBI program in the Indaga S&T competition, with the purpose of strengthening it. The study is positivist, applied research, experimental design with pre- and post-testing to a single group. The sample of 25 third-grade high school students from the 7 de Enero Technical Educational Institution (IET) was selected from the population of 182 students, by non-probabilistic convenience sampling.

From the general objective, whose statistical results with p - value of 0.00, theoretical bases and comparisons with studies carried out in varied contexts, allowed to conclude that the methodology proposed in the ECBI – Indaga program, significantly strengthens the Indaga competence of S&T, therefore its application in students of all educational levels is proposed.

***Key words**: ECBI Program, Inquiry competition, Science and Technology, third grade students, scientific inquiry.*

I. INTRODUCTION

The knowledge society of which we are a part is characterized by the leading role that the knowledge obtained has [1]assumed as a product of rigorous procedures and guidelines of the research process, requiring critical individuals, capable of proposing innovative alternatives to the problems of each context. This training must be provided rigorously from school through innovative methodological strategies whose main axis in the formation of generations is scientific inquiry.

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Inquiry competence is defined as the student's ability to build knowledge about their natural environment, through scientific and reflective procedures in relation to the knowledge obtained through curiosity, amazement, skepticism, and other attitudes typical of inquiry (Minedu, 2016a). On the other hand, the ECBI**, Inquiry-Based Science Education, is a** program that aims to introduce the world of science to school in a dynamic and fun way, seeking that students of all ages participate in the research process through learning about it, in such a way that it becomes part of their culture (Rodríguez, 2014).

International studies conducted in Spain, Norway, Australia and Ecuador by Nicolás-Castellano et al. (2023); Seland and Jegstad (2023); Gillies (2023) and Andrade and Guevara (2022) found the need to guide the teaching of science from the professional training of teachers, in order to strengthen inquiry in them, on the basis of which they will have the ability to promote scientific culture in their students. Likewise, in Peru, Rufasto (2023); Star and Pine (2022); Mendoza (2021) and More (2021) agreed in proposing the use of active methodologies in a timely manner as an alternative option to the gap identified between theory and practice typical of the old or traditional method.

Considering the results of the evaluation of the Programme for International Assessment(PISA) of 2018, where Peru is located in one of the lowest levels of performance in science, with 80% of students whose performance is lower than expected, the need to address this educational need, which has a negative impact on the achievement of competencies (Organisation for Economic Co-operation and Development [OECD], 2019).

Focusing on this reality in the local context, the Technical Educational Institution "7 de Enero" of the Tumbes region (IET), has 10 technical option workshops; its geographical scope covers both rural and urban areas of the district of Corrales, whose families are mainly engaged in agriculture and commerce; At the secondary level, its student population exceeds 900 students, attended by 57 teachers. In this house of basic education, a problem was identified characterized by the majority practice of traditional methodology and scarce achievements in areas linked to research.

This is evident in the achievements obtained in the census evaluation applied in 2018 and 2019, where 9.5% and 8.7% respectively in reading were obtained at the satisfactory level. On the other hand, in mathematics, it was only possible to raise one percentage point in the satisfactory level, as 8.2% and 9.3% were obtained. In Science and Technology (S&T), in 2018 the satisfactory level was 7.1% and in 2019, it decreased to 6.3%. These data show that there is difficulty in applying research processes, i.e., the methodology applied by teachers affects the strengthening of competence linked to research (Minedu, 2019).

According to the sections described above, it seeks to improve the diagnosis identified in relation to the current condition of the Indaga competence, this reality invites to leave traditionalism in teaching in the past to open the doors to the methodology present in the ECBI program and implement its application in the pedagogical work in order to train individuals with critical vision and problem-solving capacity. The situation described allows us to raise the problem on which this research is based: How does the ECBI program strengthen the Indaga competence in the area of S&T in students of an IET - Tumbes, 2023?.

The general objective of this study was to determine the extent to which the following statements were made in the preceding paragraph: the ECBI Program strengthens the Indaga competence in the area of S&T in students of a ETI - Tumbes, 2023. The following specific objectives are derived: to determine the extent to which the ECBI Program strengthens the problematizing situations dimension to do inquiry, of the Indaga S&T competition in students of an ETI - Tumbes, 2023; Likewise determine to what extent the ECBI Program strengthens the design strategies for inquiry dimension of the S&T Inquiry competency in students of an ETI - Tumbes, 2023; similarly, to determine to what

extent the ECBI Program strengthens the dimension of generating and recording data and information, of the Indaga S&T competition in students of an IET - Tumbes, 2023; To what extent, the ECBI Program strengthens the dimension of analyzing data and information, of the Indaga S&T competency in students of an ETI - Tumbes, 2023 and determine to what extent the ECBI Program strengthens the dimension Evaluate and communicate the process and results of its inquiry, of the Indaga S&T competency in students of an ETI - Tumbes, 2023.

Similarly, the hypotheses H1: The ECBI Program significantly strengthens the Indaga competence of the S&T area in students of a HEI -Tumbes, 2023. In contrast, the null hypothesis is proposed: H0: The ECBI Program does not significantly strengthen the Indaga competence in the area of S&T in students of an IET -Tumbes, 2023. The specific hypotheses proposed were: The ECBI Program strengthens the problematizing situations dimension to do inquiry, of the S&T Inquiry competition in students of an ETI - Tumbes, 2023; the ECBI Program strengthens the dimension of designing strategies to do inquiry, of the Indaga de S&T competency in students of an ETI - Tumbes, 2023; t he ECBI Program strengthens the dimension of generating and recording data and information, of the Indaga de S&T competency in students of an IET - Tumbes, 2023; The ECBI Program strengthens the dimension of analyzing data and information, of the Indaga de S&T competition in students of an EIT- Tumbes, 2023; The ECBI Program strengthens the dimension of the Indaga S&T competition in students of an EIT-Tumbes, 2023 .

Taking into account the criteria established by Díaz and Hernández (2002), regarding the usefulness of all research, it is justified by: Its convenience, since it has demonstrated optimal results in achieving educational improvements related to the teaching of areas linked to science, and molding individuals with a research profile; social relevance, as the findings resulting from this research contribute significantly to the progress of society, by forming individuals capable of facing current challenges.

In relation to practical implications, it seeks to replace traditionalism in the direction of the science education process; Likewise, the principles of the ECBI represent its theoretical value since they constitute the constructivist foundations necessary to learn to do inquiry in a dynamic and fun way through the area of S&T and, finally, their use contributes to promoting inquiry as part of learning-teaching at various levels. Its effectiveness derives from an instrument validated by experts, reliable, suitable for application in various realities, which represents its methodological usefulness.

Research related to the dependent variable at the international level, such as those carried out by Sanmartín (2022), who proposed PBL as a relevant methodology strategy for critical individuals; Revuelta et al. (2022), in the book Advances and Challenges for Educational Transformation, centralize gamification for science teaching; Andrade and Guevara (2022) demonstrate that the flipped classroom is appropriate for promoting autonomy in the research process; Makamu and Ramnarain (2022), proposed the 5E Simulations (5 stages) to teach science; Álvarez and Rubio (2021) found in the use of virtual libraries an advance in the crystallization of processes linked to inquiry; Chinchilla and Contreras (2021), investigated the effectiveness of the use of search software in the consolidation of research skills. The aforementioned studies obtained positive results to their objectives, so it is concluded that the inquiry can and should be promoted through various methodological tools.

Similarly, in relation to the independent variable, the following studies verified the effectiveness of the ECBI in various contexts, such as the case of the research carried out by De Albuquerque and Da Costa (2023) in the limited reality of the Brazilian Amazon; Areepattamannil (2020) related the ECBI to student attitude, while Gómez and Suárez (2020) related it to the school climate and the teaching proposed in the inquiry program; Kersting et al. (2023) reviewed the literature on ECBI and found that it gives

students greater freedom to make decisions; Similarly, Maximo-Pereira and Cunha (2021) conducted a review of the approach of teachers to the (EnCI-Brazil), highlighting the role of the trained and motivated teacher in the application of the EnCI in order to enhance its effectiveness.

In the Peruvian context, studies have been carried out aimed at the Indaga S&T competence, such is the case of Ramos et al. (2022), who aim to identify the development of the capacities of this competence through activities proposed on the Ministry of Education's platform Aprendo en casa (AeC). Similarly, Nina (2023) proposed the Platform called Khan Academy (KA) with the purpose of consolidating the learning of the Indaga competence. Along these lines, Cosme et al. (2022) presented the effects of the use of technology as a pedagogical tool in Indaga. Likewise, Sandoval (2022) investigated the application of educational software with the purpose of optimizing S&T learning - Indaga competence. These studies concluded that the addition of innovative resources linked to the technology that currently predominates plays a decisive role in strengthening this research competence, as proposed by the ECBI program in its four stages.

There are also studies that involve active methodological strategies in order to improve science learning, examples of which are: Domínguez (2022), who proposed Applying PBL in university students in order to know its effectiveness in the consolidation of research competence. In this sense, Rimac and Esteban (2021) proposed the use of the School Meteorological Service (SME) strategy as part of science teaching with the purpose of strengthening the Indaga competence. They concluded that these strategies contribute positively to the learning of science, especially the aforementioned competence.

Along these lines, various literatures have been reviewed in order to identify the level of contribution of active methodology in science teaching, thus Urdanivia et al. (2023), directed it to the ECBI and Noriega (2022), to the PBL, finding that the ECBI, combined with relevant pedagogical strategies, benefits the construction of knowledge and the development of research skills.

Theoretical framework

In relation to research, (Kerlinger, 1987 as cited in Bisquerra, 2009), defined it as a systematic, critical and controlled activity that produces scientific knowledge, based on reliable and reliable sources, classified according to Latorre, et al. (1996), in delimited phases of input, process and output, through which the researcher: search for and select fonts; It analyzes, evaluates and preserves materials and distributes collected data.

Likewise, in 1996 the National Research Council (NRC) emphasized the urgency of promoting scientific literacy in our current context, where scientific information must be handled daily by individuals, mainly in matters related to technology and science.

In relation to the ECBI, Rodríguez (2014) described this program as a didactic methodology that aims to bring the world of science closer to the school, motivating the student to appropriate its processes and integrating this knowledge into their culture. In such a way that the individual builds his knowledge relying on the permanent guidance of the teacher.

This research proposed the implementation of the Inquiry-Based Science Teaching Program (ECBI), as an alternative for the solution of the identified problem, since its nature and applicability has as scientific bases the constructivist model and theoretical foundations of the New School proposed by John Dewey and José Antonio Encinas Franco who, as a precursor of these principles, he applied them in his pedagogical work in Peru. In the same way, the principles and fundamentals of this program, as an active methodology in the teaching of science in and from the classroom, have shown

effectiveness.

In our country, the fundamentals of the New School were applied by the pedagogue José Antonio Encina Franco, who understood the need to take into account the individualities of students when planning and directing learning, emphasizing their applicability and relevance in their daily lives; for which he programmed practical and motivating activities in order to strengthen capacities that result in autonomy in learning and in making decisions. decisions, after diagnosis. For him, written assessment is not as important as the observation of attitudes, assigning it the role of examining progress in the understanding of knowledge (Encinas, 1986).

It is these processes that characterize the foundations of the ECBI, which seeks to promote the autonomy of learning in a dynamic way in the classroom. Therefore, this proposed methodology is adequate, as it encourages the application of combined activities implemented with material that encourages scientific inquiry.

It is precisely inquiry that is sought to be promoted in the area of S&T, from the competency-based approach, a term that the OECD DeSeCo Project (2005) defines as the ability to address complex cognitive demands, through the mobilization of resources that include attitudes and skills in certain contexts.

The present study is based on the competency-based approach, which, according to Tobón (2013), are complete actions of the individual in the face of situations and problems of the environment, assumed through the articulation of knowledge (being, coexisting, knowing and doing) with creativity and autonomy. Such is the case of the Indaga S&T competence, defined by Minedu (2016a) as the ability of the person to combine various capacities in order to achieve a goal in a specific scenario, proceeding with ethical and pertinent sense.

In Peru, the Ministry of Education has adopted this approach, as reflected in the CNEB Minedu, (2016a), in this normative document are the 31 competencies from which the Graduate Profile is framed, being the 20th competency whose name is Inquire through scientific methods to build knowledge (Indaga), which is part of the S&T area, which the Minedu Secondary Curriculum Program (2016b), considers as an axis in the formation of citizens with the ability to question themselves and follow the processes of inquiry, which end in decision-making based on scientific knowledge considering their social and environmental effects.

The S&T area promotes the development of 3 competencies through the approach: Inquiry and scientific and technological literacy, which is based on the autonomy of learning based on observation, curiosity and questioning of the phenomena of the context; as part of this process, students explore, dialogue, exchange points of view of reality and compare them with scientifically proven knowledge. which allow the construction of knowledge necessary to solve problems by making decisions based on science; recognize limitations and benefits of the contributions of technology and science, as well as understand their relationships with society by developing reflective and critical thinking (Minedu, 2016b).

Given the nature of this study, the research revolves around the Indaga competence, as it seeks to encourage the student to construct knowledge due to the functioning and structure of their artificial and natural environment, making use of the procedures inherent to science, promoting reflection on the knowledge obtained and how it was obtained. mobilizing attitudes such as skepticism, astonishment, curiosity, among others (Minedu, 2016b).

This competence is organized and constituted by the following skills: Problematizing situations for inquiry, focused on observation, guides the formulation of

questions that can be investigated in relation to natural phenomena and facts, as well as the formulation of hypotheses; Design strategies to carry out research, through the phases of the scientific method, sequential activities are proposed aimed at building procedures, selecting instruments, materials and data in order to carry out the verification of hypotheses to refute or verify their validity; Generate and record data or information, select relevant instruments and techniques for the collection, organization and recording of reliable data related to the study variables, and the testing of hypotheses; Analyze data and information, interpret information resulting from the inquiry to compare them and thus reach conclusions based on the validity or not of the hypotheses and; Evaluate and communicate the process and result of the inquiry, determine and report the drawbacks present during the inquiry process in such a way that the level of acceptance of the answer offered to the question raised is questioned (Minedu, 2016b).

The competency-based approach aims to develop skills and abilities in students, inquiry is promoted at an early age, taking advantage of the child's innate abilities, such as curiosity in experiential activities and interaction with their natural environment; However, the educational institution of application of this study does not take advantage of the opportunities to investigate that are tacitly present in the natural environment, by applying inadequate methodology for this purpose, which is detrimental to the achievement of the desired graduation profile established in the governing documents of our education.

Despite this approach, it is notorious that the traditional school has not disappeared in its entirety, which is why Urteaga, (2008), elaborates the profile of the teacher who practices this methodology: a mediator, not an instructor; the student is at the center of the educational process, not the contents; uses active methods because they encourage critical and creative thinking, They promote cooperation and autonomy by taking advantage of the potential of each student.

After this overview of both schools, it is clear the urgency of being the managers of a new era in Peruvian education, starting in the classrooms of the 7 de Enero Technical Educational Institution in the Tumbes region, demonstrating that not even the onslaught of nature can stop the willingness to change of the teachers of this border region. Well, we will leave behind rote memorization, expository and tedious classes that do not contribute to the development of skills such as Indaga, which promises to train individuals of the 21st century.

As a complement to the effective development of the inquiry competence, the National Academy of Sciences promotes the implementation of the ECBI as a methodological alternative, described by Rodríguez (2014) as a didactic methodology that aims to bring the world of science closer to the school, whose results show autonomous, creative, critical, audacious, cooperative individuals, among other characteristics of a researcher, He was molded by applying the scientific method in the simplest activities of his daily life, motivating him to appropriate his processes and integrating this knowledge into his culture.

This methodology, defined by Lena (n.d.), a member of the Hands in the Dough - "La Main à la pâte" program promoted by the European Academy of Sciences, as an innovative program to teach science, which has been adopted by several countries of the American continent since 1996, because it requires inventors, researchers and innovators, who are not trained in universities, They are conceived from a very young age, in schools, by teachers with an interest in the education of their students.

This program is called by various names: In Colombia, Little Scientists; Panama, Let's Do Science; Brazil, Hands on the Dough; Argentina, Science Literacy; Mexico, science in your school; Chile, Inquiry-based science education; among other similar ones in several countries. Despite being created in the United States, as an innovative alternative to be applied in the so-called Difficult Neighborhoods, it is the Nobel Prize

winner Georges Charpak, who takes it to his native France, where it is currently applied through the National Academy of France (Rodríguez, 2014).

The objective of the program is to forge the scientific spirit in students through simple and interesting activities, practical and fruitful, with rigor, and simple equipment. It seeks that the student comes into contact with direct reality and concrete matter, motivating the formation of the investigative spirit that every child possesses, initially taking curiosity and questioning phenomena in their environment, as well as the application of group activities, in such a way that interest in science is promoted. that enables him to adapt to this society in an assertive way (Lena, n.d.).

According to Rodríguez (2014), thisprogram consists of four rotating stages: Focus, allows exploration, delimitation of the problem, collection of previous knowledge about the identified problem, elaboration of hypotheses; Explores, or discusses, guides the development of hypothesis testing procedures, conducts research, data collection; Compare, here conclusions are drawn, findings are contrasted with previous ideas, new terms are introduced, opinions about the process and the problem are shared freely; Application, transfer of knowledge in different contexts for the consolidation and verification of learning, students propose new research or extensions of it, where it is possible to apply what they have learned.

II. METHODOLOGY

This study is in line with the positivist paradigm, which distinguishes reality in a practical and objective way, since all knowledge arises from concrete reality (Pérez, 2015). According to Ríos (2017), research is of the Applied type, because it is concrete and seeks to apply theoretical knowledge in order to solve a specific problem.

In relation to the sample, according to Hernández and Mendoza (2018), a subset of the population is disaggregated which is called the sample, from which data are collected; Arias (2012) described it as a truly representative part of it; After applying the "finite" formula, there are times when it is impossible to measure the variables in the population determined for the study or in population groups.

That is why the formula for determining the sample is based on the concept of probability; where, in a probability sampling, it is possible or probable that the elements that make up the population will be selected as part of the sample. For this research, the non-probabilistic sample was determined, made up of 31 students (section D), of which 6 were excluded, leaving the sample delimited by 25 students of the IET 7 de Enero of the district of Corrales, to whom the methodological proposal elaborated was applied.

The sample was determined considering the inclusive criteria of the population mentioned above, adding the signature of the student's legal guardian or parent in the consent; of exclusion, not having the approval of guardians or parents to participate in this research.

The technique used, according to the variables of this study, is the survey and the instrument is the questionnaire; taking into account Rojas (1998), for whom data collection is used to obtain information, while for Behar (2008) it means making use of a diversity of tools and techniques, feasible to be used by analysts in order to develop computer systems, these can be questionnaires, interviews, graphs, surveys, observations among other similar ones.

Procedure

To carry out the research, the diagnosis of the variables linked to the study was carried out in the selected educational institution, whose information allowed to direct the research procedure, then the pre-test and post-test were elaborated, the validation in the opinion of experts, then, the authorization of the director of the Technical Educational Institution 7 de Enero of the district of Corrales was requested. by means of a letter of introduction (attached to the thesis in numeral 10) and to the parents of the students who

participate, through a signed consent (attached to the thesis in numeral 4), in order to begin the collection of data (pre-test).

Subsequently, after receiving the authorization for the application of the instruments, the students were informed about the questionnaire and what is sought with its application, the respective indications were provided and the instrument was applied. The analysis and processing of the information obtained was carried out, then the ECBI program was intervened, then the post-test was applied and the analysis and processing of the information was carried out for the elaboration of conclusions.

III. RESULTS

This research was conducted with the purpose of determining the degree to which the ECBI Program strengthens the Indaga competence in the area of S&T in students of an IET - Tumbes, 2023. In order to achieve this goal, the ECBI – Indaga program was designed, consisting of 15 sessions of experimental activities where the stages of the ECBI were inserted into the capacities that are part of the Indaga competition, in accordance with what is established in the National Curriculum.

In the proposed activities, the theoretical foundation was Constructivism, whose guidelines feed the principles of the New School, its most emblematic representatives being John Dewey and José A. Encinas, in our country. This pedagogical current, in its beginnings, marked a clearly defined line in front of the traditional School, since it relegated the teacher to the background, giving the student a leading role in their learning, which caused an excessive furor at that time, however, it was strengthened by other similar currents and became a solid proposal for change in the emerging society that needed individuals capable of being their own agents in the solution of the problems that surrounded him.

These principles are the solid foundation on which the ECBI program has been built, whose stages find in the capabilities of the Indaga competition, its similar, in relation to the steps of the scientific method.

Given the nature of the study, delimited and consecutive steps were followed: first, after applying the pilot test to students of the same grade in the experimental group, the sample to which the sessions that are part of the program was applied was selected, and finally the posttest, which allowed data to be collected in order to determine the final results of the process.

As part of these steps, descriptive and inferential statistical methods were then applied that relate the objective of the study to the dimensions. Regarding the first, the data from the test prior to and after the application of the ECBI – Indaga proposal were subjected to procedures that culminated in the identification of standard deviation, mean, variance, and mode.

As for the descriptive statistics, the data obtained were subjected to statistical tests in the SPSS program, which correspond to the measures of dispersion and central tendency.

Tabla 1

Descriptive statistics for the competition variable inquired for the pretest

Dimensions	M	Me	Mo	OF
Problematizing situations	3.40	3.00	3.00	0.707

Strategize	3.48	4.00	4.00	1.005
Generate data	3.28	3.00	3.00	0.843
Analyze data	3.56	4.00	4.00	0.768
Evaluate & Communicate	3.48	4.00	4.00	0.872

Note. Pretest of the Indaga competition.

In this table we can see the descriptive statistics for the pretest, where the average number of students mentioned that, sometimes (3) they execute each of the five dimensions, getting closer to the almost always, the dimension analyzed (M=3.56). Medians are relatively close to arithmetic means. La moda indicated that most of the students mentioned that problematization and the generation of data and information are sometimes carried out (3); On the other hand, strategy design, data analysis, as well as evaluation and communication are almost always carried out (4). The standard deviation is low in all dimensions, so these data are not scattered from the arithmetic mean.

Tabla 2 Descriptive statistics for the competition variable inquires for the posttest

Dimensions	**M**	**Me**	**Mo**	**OF**
Problematizing situations	4.52	5.00	5	0.653
Strategize	4.48	5.00	5	0.770
Generate data	4.24	4.00	5	0.926
Analyze data	4.60	5.00	5	0.707
Evaluate & Communicate	4.32	5.00	5	0.852

Note. Posttest of the Indaga competition.

Table 4 shows descriptive statistics for the posttest, where the average number of students mentions that they almost always (4) execute each of the five dimensions, being closer to the always, the dimension analyzed (M=4.60). Medians are relatively close to arithmetic means. The fashion indicates that most of the students mentioned that they always (5) carry out the problematization and generation of data, the design of strategies, analyze data and finally, evaluate and communicate. The standard deviation is low in all dimensions, so the data are not scattered from the arithmetic mean.

In reference to the normality test, the following was taken into consideration:
Ho: Data with normal distribution
Ha: Data without normal distribution
Significance, level 0.05

Shapiro-Wilk was used as a test of normality, as the sample size was less than 30.

Tabla 3 Shapiro-Wilk pre- and post-test normality test in the experimental group

Dimension	Pretest			Postest		
	Statistical	Gl	P	Statistical	Gl	Gis
Problematizing situations	,938	25	,001	,706	25	,000
Strategize	,891	25	.012	,674	25	,000
Generate data	,859	25	,003	,767	25	,000
Analyze data	,856	25	,002	,597	25	,000
Evaluate & Communicate	,853	25	.002	,307	25	,000

Note. This table compares Shapiro–Wilk pre- and post-test results.

Table 5 shows the Shapiro-Wilk test and its level of significance. For the pretest and posttest, the p-values in the five dimensions are lower than the minimum established value of 0.05; deducing that these data do not follow a normal distribution. Therefore, it was decided to use a non-parametric test.

Hypothesis testing

This research has used Wilcoxon's non-parametric statistical test; This allowed us to compare the results of the same unit of study obtained in both tests, corresponding to the dependent variable and its dimensions.

Specific objective 1. To determine to what extent the ECBI Program strengthens the Problematize Situations dimension of the S&T Inquiry competency in students of a HEI - Tumbes, 2023.

Specific hypothesis 1

H1 The ECBI Program strengthens the problematize dimension of the S&T Inquiry competition in students of an IET - Tumbes, 2023.

H0 The ECBI Program does not strengthen the problematizing situations dimension of the S&T Inquiry competition in students of an IET - Tumbes, 2023.

Tabla 4

Results of the Wilcoxon Test for the Problematize Situations Dimension

	D1: Problematize situations
Z	-4,203B
Asymptotic (bilateral) sig.	,000
to. Test for Wilcoxon Signed Ranges	
b. Based on negative ranges.	

Note. Wilcoxon to problematize situations.

Table 6 shows results according to the problematize dimension of the experimental group, with the p-value of 0.000, being lower than the significance value of 0.05; then the existence of significant differences between the pre- and post-test was demonstrated. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted.

In conclusion, it is concretely evidenced that the ECBI Program strengthens the problematizing situations dimension to do inquiry, of the S&T Inquiry competition in students of an IET - Tumbes, 2023.

Specific objective 2. To determine to what extent the ECBI Program strengthens the design strategies dimension of the Indaga S&T competency in students of a HEI - Tumbes, 2023.

Specific hypothesis 2
H1 The ECBI Program strengthens the design strategies dimension of the Indaga S&T competition in students of an IET - Tumbes, 2023.
H0 The ECBI Program does not strengthen the dimension of designing strategies, of the S&T Inquiry competition in students of an IET - Tumbes, 2023.

Tabla 5 Results of the Wilcoxon Test for the Designing Strategies Dimension

	D2: Strategize
Z	-3,566b
Asymptotic (bilateral) sig.	,000
to. Wilcoxon Sign Range Test	
b. Based on negative ranges.	

Note. Wilcoxon to strategize.

Table 7 shows the results according to the dimension of designing strategies of the experimental group, with the p-value of 0.000, being lower than the significance value of 0.05; then it was shown that there are significant differences between the pretest and the posttest; therefore, the null hypothesis could be rejected and the alternative hypothesis accepted.

In conclusion, the evidence allows us to affirm that the ECBI Program strengthens the design strategies dimension of the Indaga S&T competition in students of an IET - Tumbes, 2023.

Specific objective 3. To determine to what extent the ECBI Program strengthens the dimension of generating and recording data of the Indaga S&T competency in students of a HEI - Tumbes, 2023.

Specific hypothesis 3
H1 The ECBI Program strengthens the dimension of generating and recording data of the Indaga S&T competition in students of a HEI - Tumbes, 2023.
H0 The ECBI Program does not strengthen the dimension of generating and recording data, of the Indaga S&T competition in students of an EIT - Tumbes, 2023.

Tabla 6 Wilcoxon Results for the Generate and Record Data Dimension

	D3: Generate and record data
Z	-3.338b
Asymptotic (bilateral) sig.	,001
to. Wilcoxon Sign Range Test	
b. Based on negative ranges.	

Note. Wilcoxon to Generate and Register

Table 8 presents the results according to the dimension of generating and recording data of the experimental group, whose p-value is 0.001, lower than the significance value of 0.05; then it was shown that there are significant differences between the pretest and the posttest; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted.

In conclusion, there is sufficient evidence to affirm that the ECBI Program strengthens the dimension of generating and recording data of the Indaga S&T competition in students of an IET - Tumbes, 2023.

Specific objective 4. To determine to what extent the ECBI Program strengthens the data analysis dimension of the Indaga S&T competency in students of a HEI - Tumbes, 2023.

Specific hypothesis 4

H1 The ECBI Program strengthens the data analysis dimension of the Indaga S&T competition in students of an IET - Tumbes, 2023.

H0 The ECBI Program does not strengthen the data analysis dimension of the Indaga S&T competency in students of a HEI - Tumbes, 2023.

Tabla 7 Wilcoxon Results for the Analyze Data Dimension

	D4: Analyze data
Z	-3,686b
Asymptotic (bilateral) sig.	,000
to. Wilcoxon Sign Range Test	
b. It is based on negative ranges.	

Note. Wilcoxon to analyze data

Table 9 shows results based on the dimension of data analysis of the experimental group, with the p-value of 0.000, being less than the significance value of 0.05; then it was shown that there are significant differences between the tests applied; therefore, it was feasible to reject the null hypothesis and accept the alternative one.

In conclusion, in view of this evidence, it could be stated that the ECBI Program strengthens the data analysis dimension of the Indaga S&T competence in students of an IET - Tumbes, 2023.

Specific objective 5. To determine to what extent the ECBI Program strengthens the evaluate and communicate dimension of the Indaga S&T competency in students of a HEI - Tumbes, 2023.

Specific hypothesis 5

H1 The ECBI Program strengthens the dimension of evaluating and communicating, of the Indaga competence of S&T in students of an IET - Tumbes, 2023.

H0 The ECBI Program does not strengthen the dimension of evaluating and communicating, of the Indaga de S&T competency in students of an IET - Tumbes, 2023.

Tabla 8 Wilcoxon Results for the Evaluate and Communicate Dimension

	D5: Evaluate and communicate
Z	-2,870B
Asymptotic (bilateral) sig.	,004
to. Wilcoxon Sign Range Test	
b. It is based on negative ranges.	

Note. Wilcoxon to Evaluate and Communicate

Table 10 shows results according to the evaluate and communicate dimension of the experimental group, with the p-value of 0.004, being lower than the significance value of 0.05; then it was shown that there are significant differences between the tests applied to the unit of analysis; therefore, the null hypothesis could be rejected and the alternative hypothesis accepted.

In conclusion, the existence shown is sufficient to affirm that the ECBI Program strengthens the evaluate and communicate dimension of the Indaga S&T competence in students of an IET - Tumbes, 2023.

Overall Objective

To determine the extent to which the ECBI Program strengthens the Indaga S&T competence in students of a HEI - Tumbes, 2023.

General hypothesis

H1 The ECBI Program significantly strengthens the Indaga S&T competency in students of an ETI - Tumbes, 2023.

H0 The ECBI Program does not significantly strengthen the Indaga S&T competency in students of a ETI - Tumbes, 2023.

Tabla 9 Results of the Wilcoxon test for the inquiry competition variable

	Variable: Indaga Competition
Z	-3,739b
Asymptotic (bilateral) sig.	,000
to. Wilcoxon Sign Range Test	
b. It is based on negative ranges.	

Note. Wilcoxon for the Indaga competition

Table 11 shows results obtained as a function of the Indaga competence of the experimental group, with the p-value of 0.00, being lower than the significance value of 0.05; therefore, it is shown that there are significant differences between both tests applied to the unit of analysis; therefore, it was feasible to reject the null hypothesis and accept the alternative one.

In conclusion, given the sufficient existing evidence, it was feasible to affirm that the ECBI Program significantly strengthens the Indaga S&T competence in students of an ETI - Tumbes, 2023.

IV. DISCUSSION

As a result of the research process, results were obtained that allow us to present in this section, through the inductive method, a detailed explanation of the effectiveness of the ECBI program as an enhancer of the development of the dimensions of the Indaga competence established for the purposes of this study, in the search to train individual researchers from secondary education, in order to contribute significantly to the development of their social context.

In relation to the first specific objective, the Wilcoxon test shows the p- value of 0.000 which is less than 0.05; This shows that there are significant differences between the pretest and the posttest; therefore, the null hypothesis was rejected and the alternative

hypothesis was accepted, concluding that the proposed program strengthens the problematize dimension of the Indaga S&T competition in students of a HEI - Tumbes, 2023.

Among the studies carried out in relation to this specific objective, Nina (2023) is located, whose statistical results showed a p>0.05 when using the Mann Whitney U test, since the data are not normal, so the null hypothesis is accepted and the alternative rejected, concluding that the proposal does not influence the learning of the problematized dimension. In the case of this dimension, the researcher obtained results contrary to those expected, which did not determine the application of the proposed platform to strengthen the Indaga competence in the study of Hydrocarbons, since in all the dimensions of this variable, 20% accepted H0.

In the case of Sanmartín (2022), he argues that PBL increases motivation and school performance in the first years of school, demonstrating that this active methodology favors problematization, which stimulates them to inquire about aspects that they observe and do not understand. For (García, 2014 as cited in Sanmartín, 2022) PBL favors learning motivation.

Similarly, Noriega (2022) states that PBL seeks to identify and apply a solution or reduction of the effects of a problem through challenging activities, whose main characteristic is work in small groups, the final product gives satisfaction to the student, as it identifies his contribution to society, which is valuable for him. For (Morales & Landa, 2004 as cited in Noriega, 2022), this process consists of eight phases, among which problematization stands out, as it identifies the problem, analyzes it, and then interacts with its peers and teacher.

The theoretical basis that sustains the application of this methodology is the New School, since it proposes to leave the expository classes to give way to activities that involve the student, as stated by Gellon et al. (2005), science is internalized in mental processes when it is taught freely, leaving the walls that form a classroom, with the permanent guidance of the teacher. Such is the case of PBL: Project-based learning, which promotes the student's reasoning by identifying problems or proposing projects that require a proposed solution; This study seeks to promote the development of the learner's research skills by proposing the pertinent use of active methodology in the area of science.

Regarding the second specific objective, a p- value of 0.000 was found, which demonstrates the existence of differences between the tests applied, therefore, the null hypothesis was rejected and the alternative hypothesis was accepted, directing the conclusion to affirm that the methodological proposal strengthens the design dimension, of the S&T Inquiry competence in students of an ETI - Tumbes, 2023.

Along these lines, Nina (2023), when performing the hypothesis test through Mann Whitney's U, found a significance of less than 0.05, which is why the alternative hypothesis is accepted, i.e. this researcher's proposal significantly influences the learning of this dimension. Similarly, for Sanmartín (2022), PBL favors the development of the design dimension by promoting autonomy in the student, as it seeks to take the reins of their learning, In this way, the development of creativity is encouraged, since everyone raises their ideas to solve the problem, which is the product of the activity carried out.

Within this framework, Revuelta et al. (2022) propose a Classroom of the Future, where the development of skills of the present century, including inquiry, is encouraged through active methodologies, such as gamification. The games that make it up provide the student with the possibility of organizing themselves in such a way that they pass through the different stations of the classroom (in which there are activities according to each process), making use of the freedoms explained by the teacher, which allow them to reuse, conserve, combine, modify and redistribute for which the students have to trace a route to

follow. In this way, creativity and autonomy are encouraged in the elaboration of the steps to follow in the class – game.

Likewise, Chinchilla and Contreras (2021) identify a high percentage of teachers with low knowledge and mastery of virtual tools, especially search engines, repositories, databases, and others that strengthen the inquiry process by making use of disaggregated information from reliable sources. To counteract this fact, a tool has been developed that seeks to reduce the negative consequences of this problem. It was found that the surveys applied before and after the use of this technological tool show progress in the development of the design dimension: justifying the degree of reliability of sources.

Following this route, Andrade and Guevara (2022), after applying the instrument, identify a preference in the use of the flipped classroom in learning. By applying Shapiro-Wilk, it was demonstrated that there was a normal distribution and more than 90% of teachers innovating with active methodologies in the direction of learning. The flipped classroom means taking the class home and doing the homework in the classroom, with the guidance of the teacher, so it is sought that it is the student who proposes his work plan in relation to the activities and the various material that he has on the platform, material that he can choose according to his own nature in learning.

As can be seen in the preceding sections, there is a variety of strategies and educational support that contribute to the strengthening of research capacities, so the teacher, following Bruner (1972), must surround the student with opportunities to develop autonomous learning indirectly and directly, providing him with the opportunity to activate mental processes that result in the consolidation of research competence.

In reference to the third specific objective, the results show a p- value of 0.001, such differences allowed rejecting the null hypothesis and accepting its alternative similar, concluding that the ECBI program strengthens the dimension of generating and recording data and information, of the Indaga S&T competence in students of an IET - Tumbes, 2023.

In the study carried out by Nina (2023), a level of significance is found with $p<0.05$, which allows us to delink the null hypothesis and admit the alternative one; In other words, the proposal strengthens the learning of the Generate Data dimension.

In the case of De Albuquerque and da Costa (2023), the results of their study indicate that teachers working in the Brazilian Amazon encounter texts, materials, and resources that do not adjust to the reality and diversity of the area, which, added to other aspects, decrease the effectiveness of learning achievement. The research was characterized by the application of surveys whose data are analyzed and systematized in tables, tables and graphs that allow decisions to be made and proposals to be presented to the educational authorities of the region and the government.

In another context, Kersting et al. (2023) in order to identify which factors influence the improvement of the quality of science teaching, observe and record classes in twenty lower secondary and primary classrooms, then these images are analyzed following the guidelines of a manual prepared for this purpose. The findings show greater independence in decision-making, class participation, and overall quality as students. This makes it clear that the development of the generate and record dimension contributes to the consolidation of other capacities necessary in all researchers.

On the other hand, Urdanivia et al. (2023) carry out a literature review in relation to the learning and teaching of science, the basis of their study being to collect data through an instrument, classify, determine priorities, organize the information in tables, and prepare graphs that allow a real analysis leading to making correct decisions on the topic under study.

The main purpose of the application of dynamic methodology in class is to promote inquiry framed in the competency-based approach, which DeSeCo of the OECD (2005) understands as the mobilization of a variety of resources in specific contexts.

Having this clear approach and, in view of the identified problem, we seek to strengthen the development of competencies in students through spaces, environments, tools, resources, among others, that awaken in the learner the taste for science and its processes. In order to achieve this goal, it is the responsibility of the teacher to adapt and innovate in his or her daily work.

Taking into account the fourth specific objective, the presence of significant differences between the tests applied before and after the implementation of the activities that are part of the program is shown, since for p the value of 0.000 shows that there are significant differences between the pretest and the posttest; therefore, the null hypothesis was rejected and the alternative hypothesis was accepted. The above presents evidence to affirm that the proposal strengthens the dimension of analyzing data and information, of the Indaga S&T competition in students of an IET - Tumbes, 2023.

Similarly, Nina (2023) finds a level of significance lower than 0.05, so these estimates allow us to accept H1 and reject H0, i.e., the study's proposal significantly affects the learning of the dimension analyzed, which contributes positively to the present study.

For Domínguez (2022), critical thinking is man's ability to perform information analysis around a specific topic, which is why he assumes PBL to strengthen it. In this process, the important thing lies in the way in which the dilemma is resolved, hand in hand with the development of skills to achieve objectives.

Likewise, (Botero, 2017 as cited in Domínguez, 2022) states that developing critical thinking is the goal of all levels in education, since other social processes require various strategies that make it possible to develop skills with higher-order characteristics. It was shown that this methodology strengthens critical thinking, framed in the ability to analyze data, with the guidance and support of a teacher prepared for this purpose.

There are several strategies that encourage research in students, such is the case of simulations, as studied by Makamu and Ramnarain (2022) who find positive results to this end through the 5E simulation (five stages similar to the phases of the ECBI program), emphasizing questioning and analyzing data as an important part of critical thinking, for (Bybee, 1997 as cited in Makamu & Ramnarain, 2022) this approach facilitates the process by reorganizing and comparing initial ideas with final ones, in such a way that new concepts and skills are introduced, always with the support of the teacher.

In this framework, Álvarez and Rubio (2021) introduce the use of virtual libraries to strengthen research skills, being clear that reading comprehension is a basic axis for research, in this way the student searches, analyzes and synthesizes data, understands, internalizes and evaluates them, establishing the bases of every researcher.

On the other hand, Gómez and Suárez (2020) emphasize the importance of the school climate in the learning of research, since achieving this goal requires teamwork throughout the process, mainly in the stage of verifying hypotheses and reaching conclusions. These researchers support their position in sources that are based on Vygotsky's theory, which supports the primordial influence of the social environment on learning, to which they add the use of active methodology to develop critical thinking in schoolchildren.

This study seeks to show teachers the principles of the ECBI program as the basis for meaningful and autonomous learning, thus promoting the beginning of the revolutionary educational era in our region. In such a way that this educational actor is

sensitized so that he feels the urgency of consolidating himself as a researcher, with the profile mentioned by Urteaga (2008).

In this pathway, for the fifth specific objective, the significance results show the p-value of 0.004 for the experimental group, which indicates that there are differences between the tests applied that determined the rejection of H0 and the acceptance of$_{H1.}$ This made it possible to affirm that the proposal strengthens this dimension.

Likewise, Nina (2023), calculated the significance value, finding as a result, the value of $p< 0.05$, with which the alternative hypothesis was accepted and its null pair rejected, concluding that the Platform proposed in the study influences the learning of the evaluate and communicate dimension.

For Sanmartín (2022), PBL, as an active methodology, strengthens this dimension by fostering a self-critical spirit, as it encourages children to self-evaluate their work, which is intended to help them learn and at the same time correct their mistakes, in order to achieve optimal future results and achieve goals collaboratively.

However, Areepattamannil (2020) compares the effects of directed (traditional) and inquiry-based education, finds better results in the combination of both and demonstrates this with the results obtained in PISA. An example of this is (Denöel et al. 2017 as cited in Areepattamannil, 2020) who finds differences favorable to the combined use of these approaches, as opposed to instruction with the separate application of them.

For this researcher, although a professional program should be designed to train teachers in inquiry-based teaching, they also (Minner et al. 2010, as cited in Areepattamannil, 2020), identify the need to train science teachers with a different profile, providing them with opportunities to evaluate blended instruction in practice, following evaluation protocols such as the application of observation instruments in the classroom.

Finally, in the general objective, there are pre- and post-test values performed with the Shapiro-Wilk normality test. Wilk determined the p value of the five dimensions with indices less than 0.05 (normal data), using the non-parametric test (Wilcoxon) in order to compare the results of the same study unit. The data found showed significant differences between both tests, so H0 was rejected and H1 accepted, concluding that the proposal significantly strengthens the Indaga competence in the S&T area.

In relation to this competence, Nina (2023), performed the normality test to the general objective of her study with Shapiro Wilk, finding normal data, so the parametric Student's T statistic was applied, suitable for independent samples, it was determined that the use of the proposed platform significantly influences the learning of the Indaga competence, by obtaining data that allowed the acceptance of the alternative hypothesis and the rejection of the null hypothesis.

Similarly, Ramos et al. (2022) study the Indaga competence and its development through the Minedu Aprendo en casa platform, who found a high percentage of students at the process level in the problematize, design and evaluation skills, followed by the level achieved in generating and analyzing data, while a smaller number are at the beginning in the five capacities. By analytically reviewing these activities, they determined that they are aimed at promoting autonomy and even cooperative work in the student.

Along these lines, Cosme et al. (2022) seek to determine the influence of technology on the Indaga competition. Shapiro determined normality for the competition under study and its capabilities, finding normal data, the Mann Whitney U test was applied. After applying the pre and posttest, they identified a high percentage of students at the expected level in both groups, while at the same time better achievements were found in the experimental group. This shows that technology is a pedagogical tool, the application of which results in better achievements in the learning of science.

Similarly, Sandoval (2022) proposes the use of the PHET acronym software in order to obtain improvements in the learning of the inquiry competence, for which Mann-Whitney U was used in the contrast of the results of the tests applied to the groups, the

result of which shows that this software is effective for the achievement of the previously set objective.

In this way, the aforementioned researchers demonstrate the effectiveness of innovative methodologies to promote inquiry, for which the teacher creates or provides the pedagogical tinge to already existing tools and resources, according to what is stated by the National Research Council (1996), which emphasizes the urgency of promoting scientific literacy in a society that prioritizes scientific knowledge. For this reason, Minedu assumes the competency-based approach and regulates it in official documents Minedu (2016a) and Minedu (2016b).

Being necessary the training of individuals in competencies, Indaga represents the basis of scientific literacy and the development of critical thinking, its capabilities represent the steps of the scientific method and establish the bases of inquiry. For this reason, its development must be prioritized through relevant methodology during schooling, with the ECBI being the most appropriate for this purpose.

VI. CONCLUSIONS

On the basis of the results and the respective discussion, following the inductive method, and depending on the proposed objectives, it is concluded:

1. Based on the first specific objective, there is the p- value of 0.000 which is less than 0.05, which shows that the guidelines of the ECBI program strengthen the problematize dimension of the Science and Technology Inquiry competition in students of a Technical Educational Institution - Tumbes, 2023.
2. Regarding the second specific objective, it presents the p- value lower than the predetermined significance, which demonstrates that the principles of the ECBI program strengthen the design dimension of the Science and Technology Inquiry competition in students of a Technical Educational Institution - Tumbes, 2023.
3. The p- value of 0.001 found for the third specific objective is less than 0.05, demonstrating that the phases of the ECBI program strengthen the dimension of generating and recording data of the Science and Technology Inquiry competition in students of a Technical Educational Institution - Tumbes, 2023.
4. In relation to the fourth specific objective, the p- value of 0.000 provides sufficient evidence to affirm that the ECBI-Indaga proposal strengthens the dimension of data analysis, of the Indaga competence of Science and technology in students of a Technical Educational Institution - Tumbes, 2023.
5. In reference to the fifth specific objective, the p-value of 0.004 allows us to affirm that the theoretical and methodological bases of the ECBI program strengthen the dimension of evaluating and communicating results, of the competence Inquiry of Science and Technology in students of a Technical Educational Institution - Tumbes, 2023.
6. Taking into account the general objective, its statistical results with the p-value of 0.00, theoretical bases and comparisons with studies carried out in varied contexts, the active methodology that characterizes the ECBI – Indaga program proposed in this study, demonstrate that this methodological proposal significantly strengthens the Indaga competence in the area of Science and Technology in students of a Technical Educational Institution - Tumbes, 2023.

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