RESEARCH AS A PEDAGOGICAL STRATEGY (IEP) IN WATER RESOURCE CONSERVATION.

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Reception Date: October 18, 2023
Acceptance Date: April 12, 2024

Abstract

This thesis studies the impact of Research as a Pedagogical Strategy (IEP) on attitude changes related to the conservation of water resources, in high school students of the IEM El Encano. It begins by recognizing the importance for students of conserving water resources. Subsequently, they develop an investigation to characterize the quality of a natural water body. Finally, the changes in attitude towards the conservation of water resources achieved through their research are evaluated. This work is located within the qualitative research paradigm, with an interpretive approach and a phenomenological type. In the first part, the semi-structured interview is used as a tool to collect data; in the research with the students, a didactic sequence based on the IEP is designed and the Guttman scale is used to evaluate the changes in attitude. At the beginning, the students think that water is polluted with solid waste. They find that there is an incipient culture of care for the environment due to ignorance of the dynamics of its operation, which is reflected in the satisfaction of economic needs with the ecological services of the environment as a priority, instead of preserving them. After applying the IEP, they conclude that anthropogenic actions are the cause of the negative impact on water. Individual and collective actions in wastewater treatment stand out, as a way to protect the environment, recognizing the link between water quality, ecosystem, and human health. However, they show a medium personal willingness to participate in the environmental awareness of the community.

Keywords: Conservation, Water resources, IEP

Resumen

Esta tesis estudia el impacto de la Investigación como Estrategia Pedagógica (IEP) en los cambios de actitud relacionados con la conservación del recurso hídrico, en estudiantes bachilleres de la IEM El Encano. Se inicia reconociendo la importancia que tiene para los estudiantes la conservación del recurso hídrico. Posteriormente, ellos desarrollan una investigación para caracterizar la calidad de un cuerpo natural de agua. Finalmente, se evalúan los cambios de actitud hacia la conservación del recurso hídrico logrados con su investigación. Este trabajo se ubica dentro del paradigma cualitativo de investigación, con enfoque interpretativo y tipo fenomenológico. Como herramientas, para colectar información, en la primera parte, se emplea la entrevista semiestructurada; en la investigación con los educandos, se diseña una secuencia didáctica basada en la IEP y para evaluar los cambios de actitud, se aplica la escala Guttman. Al comienzo, los estudiantes conciben que el agua se contamina con los residuos sólidos. Manifiestan que existe una cultura incipiente por el cuidado del ambiente debido al desconocimiento de las dinámicas de su funcionamiento, reflejada en satisfacer necesidades económicas con los servicios ecológicos del entorno, como prioridad, en lugar de conservarlos. Luego de aplicar la IEP, concluyen que las acciones antropogénicas son causa de afectación negativa del agua. Destacan las acciones individuales y colectivas en el tratamiento de aguas residuales, como una forma de protección del entorno, reconociendo la interconexión entre calidad del agua, ecosistema y salud humana. No obstante, evidencian una mediana disposición personal por participar en la sensibilización ambiental de la comunidad.

Palabras Clave: Educación ambiental, conciencia ambiental, recurso hídrico, conservación, IEP.

LA INVESTIGACIÓN COMO ESTRATEGIA PEDAGÓGICA (IEP) EN LA CONSERVACIÓN DEL RECURSO HÍDRICO.

I. INTRODUCTION

This research focuses on the observation of changes in the attitudes of the students from the Municipal Educational Institution El Encano regarding the conservation of water resources. Due to its vital importance in ecosystems, this resource continues to be negatively affected by human actions. This underscores the need to strengthen the awareness of new generations concerning its care and conservation through education in schools.

Environmental education offers a wide space for the application of different strategies, among which are those based on learning based on research developed by students and teachers, such as those studies focused on topics such as didactics and pedagogy oriented to environmental conservation. (Hernández et al., 2020; Gutiérrez, 2014; Sánchez-Barbudo et al., 1995; Fajardo, 2017; Tibaduiza, 2020), environmental awareness (Bastidas y Sandoval, 2018; Boelens y Parra 2009; López y Acosta 2002; Angarita et al., 2018; Vásquez-Thorné y Núñez-Sarmiento, 2018; Cabana-Manjarrez et al. 2018),

strengthening pro-environmental attitudes (Correa y Martín, 2014; Ruíz et al., 2018; Pérez, 2011;) and recognition of environmental problems and autonomous execution of proposals (Gordillo et al., 2015; Caamaño–Guerra et al., 2018; Gaviria-Paredes et al., 2018)

The negative interaction between environment and society in the context of El Encano village, requires the intervention of environmental education to recognize the natural dynamics of the environment and, in this way, strengthen the sensitivity of the new generations in such a way that behavioral changes can be induced in favor of the protection of the factors that integrate the natural environment, especially those related to water. In this way, we seek to mitigate the negative impact of human activities as they are carried out today, in order to achieve a harmonious convergence between social progress and the inevitable interaction of human beings with their natural environment.

According to these criteria, the need arises for the use of educational tools that promote conceptual and attitudinal changes in the human-environment relationship. For the development of this study, Research as a Pedagogical Strategy (IEP) is used, which is applied in the recognition of the quality of one of the most important natural water bodies in El Encano village, hoping to show changes in the students' attitude towards the conservation of the water factor once the process is concluded.

This research is developed within the qualitative paradigm, using an interpretive and phenomenological approach. It begins by identifying the interpretations and positions presented by the students in relation to the environment and especially the water factor, using the semi-structured interview as a tool for data collection. Subsequently, a methodological sequence is designed based on IEP guidelines to characterize the water quality on a stream in the area, identifying the variables that may be the cause of the negative impact on the water. Finally, a recognition of the change in students' attitudes towards the conservation of water resources is carried out, using the Guttman scale as a data collection instrument.

The methodology used is outlined below, followed by a summary of the findings and finally the conclusions and recommendations.

II. METHODOLOGY

This research adopts the qualitative paradigm, since it is oriented towards understanding the behavior, relationships, interactions and organizational dynamics of people with their environment, without focusing primarily on quantification. The study focuses on obtaining ideographic knowledge about the phenomenon of the water factor, exploring questions that represent reality in a meaningful way, as outlined by Paz (2003) when she states that in qualitative research, in order to understand the daily events and phenomena that outline human experience, it is necessary to relate them directly to the context in which they occur.

The approach is interpretative because, being environmental research, it allows us to enter into the world constructed by the subjects and to understand the vision of its functioning based on their shared perceptions. By participating in the search for meanings and representations about the surroundings, we move towards a more inclusive and participatory environmental education. As Capocasale (2015) expresses it, on this approach when it is stated:

The goal is to penetrate the world that subjects construct and share, and to understand how they function on the basis of their intersubjective agreements. At present, it focuses primarily on the search for the meanings that subjects give to their own practices in the situations in which they act. (p.43)

This type of research is phenomenological because it seeks to go beyond the superficial facts to identify the characteristics of the environmental event under study by exploring the subjective experiences of the participants and identifying significant connections between them, in order to describe and understand the scaffolding that underlies the environmental phenomenon and its influence on their attitudes and behaviors toward nature. When relating the phenomenological type to qualitative research, Aguirre and Jaramillo (2012) argue that a description of the participants' experience of the phenomenon should be made until the essence is reached; then, the structures that make it possible (transcendental phenomenological description) should be described until the essence of the phenomena is reached based on the previous descriptions.

The population of this research corresponds to the high school students from El Encano village, who study their

secondary education in this institution; belonging to the different villages of the 18 which integrate El Encano village from the municipality of Pasto. The sample is represented by 30 volunteer students, young ladies and young people of the Municipal Educational Institution from El Encano village, belonging to the Environmental Committee of each course in the high school section, who were between 11 and 17 years old.

For the theoretical framework, a critical review and documentary analysis of theories related to the German and Latin American educational paradigms was made, where the critical-transformative and popular educational currents were found, outlining the constructivist and investigative approaches to focus the line of Research as Pedagogical Strategy (IEP). Likewise, the conceptual framework focuses the concepts and studies related to environmental awareness and education, environmental maintenance and conservation, and the water factor as relevant topics of this thesis, which represent the basis to focus its practical execution and interpretation of results.

In addition, information was obtained regarding projects that could be similar to the objectives of our study, related to the application of research as a pedagogical strategy in relation to environmental education processes in elementary school students. Such collected information facilitated the drawing up of a bibliographic information map, which led to the recognition of situations not yet studied in the field in question, in which it was possible to locate the development of this thesis. Vickery (1970) adds that one of the informative needs of the recovery methods, including documentary analysis, is to know what other scientific peers have done or are doing in a particular field.

Since this research focuses on the study of the interaction between society and the natural environment in the region of El Encano, it was decided to use the semi-structured interview as a tool to collect information because it facilitates a familiar and authentic approach with the students allowing the identification of the attitudes they have developed throughout their upbringing and the social context in which they have developed in relation to the natural environment, especially with the water factor. In this regard, Alonso (1999, as cited in De Toscano, 2009) states that in "the semi-structured interview is intended through the collection of a set of private understandings, the construction of the individual's social sense or reference group behavior of the participants.

Another tool used was the field diary, which is used during the development of a didactic sequence by participants in the sample under the guidance of the teacher, in accordance with the guidelines of investigation as a pedagogical strategy (IEP). According to Van Maanen (2011), the field diary consists of a written and systematic record of observations, reflections and relevant events that occur during the development of an activity or project. In the context of this research, the observable human-induced factors that negatively affect the water quality of a stream in the area were are recorded in a diary. This diary also contains a detailed record of the taxonomic classification of the bioindicators collected in the stream bed after the fieldwork had been carried out, which allows the assessment of the degree of potability or pollution in the different areas of the water body under study.

After collecting data from one of the streams in the village of El Encano, the Guttman scale was used as a tool to collect information to identify changes in attitudes, through questions divided into categories resulting from the identification of aspects related to attitudes towards the water factor in the semi-structured interview. Referring to this tool, Aigneren (2008) says:

The purpose of this scale is to measure attitudinal one-dimensionality - it measures only one dimension in accordance with the assumption that the whole attitude is contained in a single dimension, the options are presented in a special arrangement so that the alternatives or questions measure the intensity of appreciation or opinion. (pg.50).

III. RESULTS

A.Semi-structured interview results

The first systematic process consisted of identifying the previous perceptions and attitudes that the participants from El Encano High School have towards the conservation of environmental resources, especially water resources. This step was developed based on the thematic analysis proposed by Schütz (1973), where the semi-structured interview technique is used, which, following Boyatzis' (1998) perspective, should provide "basic elements of raw information that can be considered as significant in relation to the topic under study".

Once the questionnaire had been validated by the academic authorities, the interviews were carried out. The responses allowed the researchers to identify these four categories: pollution and environmental degradation, flora, environmental awareness and environmental culture, which are defined as follows.

Pollution and environmental degradation. Since these two aspects are directly linked and supported by sufficient arguments for the purposes of this research, we accept the criterion of Reyna (1999) who, when referring to environmental pollution, indicates that in the production, use and final disposal of any good and service, materials and energy capable of irreversibly damaging the mechanisms of nature to regenerate the biosystem and sustain life are emitted into the environment. From another perspective, environmental deterioration is often perceived as the result of human error, negligence, or irresponsibility. It is also seen as an unintended consequence of poor economic and public policy.

Based on the aforementioned general visions that support the category, several elements emerged from the responses obtained, which are represented in the following subcategories: solid waste, water resources, extinction of animal species, soil deterioration due to agrochemicals, and air pollution.

Solid Waste (C1RS): The individuals interviewed stated that they are aware of the ultimate destination of solid waste by depositing it in the sanitary landfill. They also expressed the belief that the environment is polluted by throwing this waste on the ground or burning it, which produces air pollution. The respondents feel that waste on the ground is indicative of a lack of awareness among the population about the environmental consequences of waste. They state that they retain waste from manufactured food in the pockets of their clothes or backpacks and dispose of it in containers when they find them. They also identified that the presence of tourists in La Cocha lagoon increased the volume of waste produced in El Encano village.

Water Factor (C1FH): The water factor is a unique physical entity that can be viewed as an abiotic component of the biosphere. However, its definition is more expansive when considering the intertwined environmental components that constitute an interdependent network. The dynamics of this network are intrinsically linked to the physical state and quality of water, which in turn define the characteristics of biomes and ecosystems (Andrade and Navarrete, 2004).

The students identify the contamination of the environment as a result of the disposal of waste into water sources. This has led to the deterioration of water quality, making it unsuitable for direct consumption from natural sources. The only sanitary option for consumption is boiling the water.

Animal Species Extinction (C1EEA): The sample of students concede that environmental degradation impacts the survival of animal species and that logging is a contributing factor. When forests are destroyed, animal habitats are also destroyed.

Agrochemical Soil Deterioration (C1DSPA):

A minority of those interviewed were aware that the use of agrochemicals, due to their toxicity, has a detrimental impact on the quality of arable soil, they end with pollinators and animal species, contamination of water sources, and adverse effects on food produced on the land and human health.

Air Pollution (C1CA): In this regard, the respondents indicated that the air quality is contaminated by several factors, which include: smoke from vehicles used by tourists who visit frequently, smoke generated by coal production, and smoke produced by burning solid waste in areas without access to collection vehicles. Additionally, they perceive the use of pesticides affects the health of the air.

2) Flora. This is defined as the set of species present in a given place or area. The study of vegetation focuses on vegetation communities, their structure, and flower composition (Hernández et al., 2000). For the purposes of this study, the authors divided the flora into the following subcategories: deforestation, coal production, and actions to conserve the flora.

Producción de Carbón (C2PC): En sus respuestas los entrevistados expresan que el carbón vegetal es un excelente combustible, económico que reemplaza al gas y que el uso que le dan beneficia a restaurantes y asaderos de los de cuyes, sin embargo, les es claro que la producción de este material acaba con la flora del lugar, deteriora el suelo y con ello afecta negativamente al ambiente en general.

Deforestation (C2D): Deforestation is the "cutting down" of trees and other vegetation in a wooded area. This term was more familiar to the students interviewed, who believed that cutting down the forest for coal production contributes to environmental pollution. Some tourists who visit the area engage in activities such as starting bonfires, cutting down trees, or removing plants from the place. Individuals also cut down trees and forests for the purpose of installing commercial posts, rather than conservation of the area's flora.

Coal Production (C2PC): In their responses, participants expressed their belief that vegetable coal is an excellent and economical fuel that replaces gas. They also noted that its use benefits restaurants and guinea pig barbecues. However, they acknowledged that the production of this material has adverse environmental impacts, including the destruction of local flora and deterioration of soil.

Actions to Conserve Flora (C2APCF): The participants believed that cutting down trees and bushes in El Encano should be avoided, as they purify the air and store water. They had observed that in some areas, individuals who cut down trees replant seedlings of the pruned species, while in other locations, they participate in communal labor to maintain the agriculturally productive sectors and the forest that is still preserved. As a result of the training they received at school, they have learned to plant trees, to avoid cutting down forests, and to respect the integrity of forests.

3) Environmental Awareness. This is a concept that has evolved in recent years and it is also important to cite Rachel Carson, who published the paradigmatic book "The Silent Spring", which is considered the forerunner of environmental awareness in America. Rivas-Escobar and Luna-Cabrera (2016).

Febles (2004) defines environmental awareness as the system of life experiences, knowledge, and experiences that an individual actively uses in their relationship with the environment. This description involves complex psychological processes that intertwine in a systemic way, expressing and controlling the interactions between the person and their environment. These processes include knowledge, attitudes, behavior, awareness, and human perceptions.

This category has been divided into two subcategories: awareness of the ecological services of the environment and economic development versus environmental conservation.

Awareness of the Ecological Services of the Environment (C3CSEA): Vargas (2012) asserts that the evident issues that have led to the current ecological crisis are indications of a disruption in the structure of environmental values and, consequently, in behavior towards the environment. The young people interviewed believed that a lack of knowledge about ecological processes was the main reason for low awareness of environmental care. They believed that this lack of knowledge was reflected in a lack of concern for natural resources and a lack of interest in reducing the cutting of forests and the discharge of sewage, pesticides, detergents, and solid waste into streams, as well as to neglect or ignoring the actions by private companies to prevent its contamination.

Economic Development vs. Environmental Conservation (C3DEFCA): This subcategory is summarized by the concept of 'sustainability' which, referring to the interaction between environment and society, according to Colom (2000, cited by Marcote and Suárez, 2005), implies a balance between ecological, social and economic aspects, as opposed to policies that seek only growth and development. For the students it was clear that people give more importance to economic sustenance than to the care for and conservation of the environment by maintaining the illegal production of charcoal destined for sale in the sector of El Encano and other sectors of the Pasto municipality by increasing food stalls, restaurants and hotels for the service of tourists without considering the environmental impact that these actions have by default.

4) Environmental Culture. Environmental culture should be recognized as a constant construct that reflects people's use of natural resources and their level of responsibility towards the environment (Motta, 1994; Zaragoza, 1998, cited in Mata, 2004). For this study, environmental culture was approached from the following subcategories: positive actions towards the environment and practices to reduce water pollution.

Positive Environmental Actions. (C4APFA): The interviewees attested to the value of recycling food packaging or sorting at the source many of the manufactured food wrappers, some farmers collect pesticide containers as a precautionary measure to give them to plastic recycling companies; the students commented that the education they received at school led them to act spontaneously in the correct use of water, the recycling of expired batteries, making handicrafts from solid plastic waste, and the reuse of plastic containers and the production of fertilizer from organic household waste.

Practices To Reduce Water Pollution. (C4PPDCA): The participants were aware that one of the uses of water is to dispose of household waste and its negative impact on rivers and La Cocha lagoon; some farmers use rainwater to irrigate their crops without having to divert water flows; to avoid pollution of rivers by discharging, a minority of commercial centers and households use bio-digesters; some dairy farmers use waste whey from cheese production to feed pigs; some trout farmers bury trout entrails, viscera rather than dumping them in rivers..

Conclusions of the semi-structured interviews.

For the students interviewed, the presence and poor management of solid waste was relevant as a significant factor that generated contamination in the environment of El Encano.

In the surveyed points of view, the notion that the waters of the streams of the township that feed La Cocha lagoon showed signs of pollution by anthropic action, preventing them from being consumed directly, was identified.

It was recognized that the inhabitants of the area placed a priority in satisfying their economic needs, rather than in managing or preserving the natural environment in El Encano.

There was knowledge and awareness among respondents that water resources such as flora and soil were deteriorating and that the benefits of their ecological services were diminishing.

The students believed that most of the people who live in El Encano acted unconsciously towards the environment because they were not aware of its dynamic nature, which prevented them from recognizing the effects of excessive actions that, in the long run, were harmful to the ecological services it provides.

In general, actions in favor of the conservation of natural resources have been identified by a minority of the local residents and owners of food stalls in the township, aimed at conserving the flora and water in El Encano. The fact that it is a minority suggests that the population in general had an incipient culture of environmental care that needed to be strengthened to favor its conservation.

B. Design and Development of the Pedagogical Strategy (IEP)

In terms of the methodological path of research as a pedagogical strategy, Manjarrés et al. (2016) propose the following phases:

Phase I: Creation of the research group. The workshop of the question, the formulation of the research problem.
Phase II: Methodological design. Design and application of research tools.
Phase III: Analysis of results. Conclusions, sharing of results.

Each of the above phases is broken down as described below:

1) Phase I: Creation of the research group. It is broken down into three stages as follows:
Forming the Research Student Group: it was previously conducted with young men and women of the environmental committee of every course taken at the High School Section and corresponded to the thirty students who participated in the semi-structured interviews to develop the first objective of this study.

Sharing of common-sense questions: The questions are related to the water factor in the natural environment of the village of El Encano. The students posed questions that were transformed into research questions through cultural negotiation, and at the same time they facilitated situated learning, which corresponds to the acquisition of meanings that arise from activities carried out in interaction with others, resulting in a shared meaning that is achieved through the negotiation of meanings and interpretations through active communication (Bruner, 1991).

Research problem construction: it was obtained from the questions, which made the problem-oriented learning real.

For the construction of the research problem in this type of learning, the following steps were developed: the problematic situation, the problem and the research question (Díaz, 2006), as described below:

The problematic situation: Where the knowledge and understanding of the student, upon realizing the impossibility of directly resolving a conflict, led to a synthesis of questions regarding the negative impact on the water quality of the rivers and streams that feed into La Cocha lagoon, in El Encano village.

The problem: In this regard, the group of young researchers concluded that they did not know the true cause of the negative impact on the quality of water in the natural bodies of the sector. Among the possible causes, it was assumed that there could be inadequate or unconscious actions of a domestic, agricultural, livestock or commercial nature in relation to the environment of the daily life of the inhabitants from El Encano.

Research question. In accordance with the above, the group of students summarized a research question which solution that sought to verify whether the possible causes raised for the problem were correct. The synthesized question was:

In which area of a river in El Encano is it possible to drink directly from its waters?

2) Phase II. Methodological Design. It is broken down into two stages:

Design of the inquiry trajectory: In response to the research question, students collaboratively organized proposals aimed at verifying the possible causes affecting the quality of water in natural bodies in the environmental sector of El Encano. Among the proposals, one emerged that was significant and viable: to identify how the quality of water, depending on the area of the river or stream (high, medium, or low in relief) before reaching Laguna de La Cocha, affects the existence of the forms of life that inhabit the rivers and streams.

Using this idea, students and research teachers examined options to carry out this identification. Among others, they decided to characterize the water quality of the Quillinzayaku stream in Santa Rosa, El ENCANO village, based on the presence of bioindicators and using the BMWP index, which stands for Biological Monitoring Working Party (Roldán, 2016), and the ASPT index, which means Average Score Per Taxon in English (Álvarez, 2005). After getting information about this water quality identification mechanism, the entire group outlined the steps to be developed, as it is described in the following stage.

Journey of the inquiry trajectory: This consisted of a field practice where the methods and tools defined in the previous stage were applied, serving as a synthesis of learning achievements: collaborative, problematizing, and situated. The trajectory consisted of two general processes as follows:

Collection of bioindicators of water quality. This was carried out in the high and low areas of the Quillinzayaku stream in the Santa Rosa district of the El Encano corregimiento. For this, the group of student researchers, along with accompanying teachers, collected samples of macroinvertebrates that grow on the bottom of the streambed. The sensitivity of these bioindicators to the conditions of the aquatic habitat where they are found provides an indication of the water quality in the area being sampled (Roldán, 2016). For the practice, each student used a field diary, Surber and kick nets (Roldán, 1988), as well as magnifying glasses, disposable plates, brushes, a solution of 70% ethanol, and labeled jars for the macroinvertebrate samples. Sampling in the mid-zone was planned from the beginning, but the dense vegetation surrounding the streambed in this area prevented access, making it impossible to carry out.

Taxonomic classification of the collected samples. This step was performed by the student researchers in the laboratory of the El Encano Municipal Educational Institution, with the support of the research teachers, using optical instruments such as stereoscopes and copies of the guide for studying aquatic macroinvertebrates in the Department of Antioquia (Roldán, 1988).

They were identified using the BMWP and ASPT indices to determine the water quality of the sampled locations in the aforementioned stream. These indices take into account the number of families and sensitivity scores or degrees of tolerance to eutrophication of the macroinvertebrates captured in each area (Roldán, 2016).

To calculate the BMWP index, the ecological scores of the families were simply summed according to their degree of tolerance to eutrophication. Meanwhile, the ASPT is calculated by dividing the BMWP by the number of families, see Ec. 1 (Arango et al., 2008).

$$ASPT = \frac{BMWP}{N^{o}deFamilias} \times 100$$

The classification and meaning referenced in the results of these indices are indicated in Table I.

The results obtained indicated that the water in the upper zone of the Quillinzayaku stream had a Class I quality, rated as "Good," which indicated that it was very clean water, uncontaminated, and of unaltered quality. The final values obtained are shown in Table II.

Tabla I. CLASIFICACIÓN DE RESULTADOS

Clase	Calidad	Valor del BMWP	Valor del ASPT	Significado	Color
I	Buena	> 150	> 9-10	Aguas muy limpias	
		101-120	> 8-9	Aguas no contaminadas	
II	Aceptable	61-100	> 6,5-8	Ligeramente contaminadas: se evidencian efectos de contaminación	
III	Dudosa	36-60	> 4,5-6,5	Aguas moderadamente contaminadas	
IV	Crítica	16-35	> 3- 4,5	Aguas muy contaminadas	
V	Muy Crítica	< 15	1-3	Aguas fuertemente contaminadas, situación crítica	

Fuente: elaboración propia, 2023.

Tabla II. RESULTADOS SENSIBILIDAD ZONA ALTA

Orden	Número de Familias	Número de individuos colectados	Sensibilidad de familias (BMWP)	ASPT
TOTAL	15	64	127	8,5
Calidad			Clase I >120 Aguas muy limpias No contaminadas Calidad buena	Clase I ≥6 Aguas No contaminadas Calidad no alterada

Fuente: elaboración propia, 2023.

Tabla III. RESULTADOS SENSIBILIDAD ZONA BAJA

Orden	Número de Familias	Número de individuos colectados	Sensibilidad de familias (BMWP)	ASPT
TOTAL	13	32	94	7,2
Calidad			Clase II 61-100 Aguas Ligeramente contaminadas: Se evidencian efectos de contaminación. Calidad Aceptable	Clase II > 6,5-8 Ligeramente contaminada Calidad Aceptable

Reflection: This involved reconstructing the methodological process. Experiences shared by each young researcher during the field practice and taxonomic classification were discussed, highlighting individual perceptions and viewpoints. This led to a broader understanding of the problem, thanks to collective production and the exchange of knowledge and experiences. It allowed the problem to be characterized at a level broader than initially known by all, generating the construction of knowledge regarding the researched issue.

Conclusions of the work with IEP in the Quillinzayaku Stream. They are summarized in two points, as follows:

In the upper part of the Quillinzayaku stream, there were many plants called frailejones. It is a special place, without houses or crops, where there was no pollution from waste or pesticides. Additionally, there were no animals that could contaminate the water with their waste. For all these reasons, the BMWP and ASPT indices showed that the water in this area was very clean and of good quality, Class I.

When we went to the lower part of the stream, we saw that there are more houses, and some forested areas have been cut down to make space for crops. There are also places where animals, like cows and pigs, are kept. It does not seem that the houses have a system to treat the water before it goes into the river. All of this makes the water somewhat dirty, but it is still not too bad. The BMWP and ASPT indices indicate that the water is acceptable, although there are signs that it might be slightly contaminated, hence its quality is Class II.

Therefore, the answer to the research question is expressed in the following arguments:

In the Quillinzayaku stream, located in Santa Rosa, El Encano Village, there is a site where the water is very pure and safe to drink. This is in the upper zone of the stream, where there are no people engaging in activities that could pollute the water. Thus, we can drink water directly from the river without worrying about its quality. In the lower part of the Quillinzayaku stream, we cannot drink water directly from the river because it is contaminated with animal waste, chemical fertilizers, garbage, and wastewater from human activities of people living near this river.

Socialization of results: This is carried out with the community of participants at the Municipal Educational Institution.

El Encano, by the group of participant researchers, who experienced the project from its inception.

For its execution, first, the group of young researchers is divided into subgroups, and the stages of the research process are distributed among them. Then, each subgroup creates a script and draft graphic presentations to later develop a slideshow presentation. Finally, the steps taken in the research and the results obtained are shared with the participant community, using the slideshow created by all the subgroups as support. Each participant, for the socialization, presents the part of the process they are responsible for, within a time frame of 1 to 3 minutes.

C. Analysis of Results Using the Guttman Scale

After applying the IEP to assess the water quality in the Quillinzayaku stream, the changes in attitudes generated among the sample group of participants regarding water resource conservation are evaluated. To this end, the Guttman scale, validated by academic authorities, is used. This scale consists of a questionnaire of thirty-two (32) questions, organized into eight (8) categories, arranged in stepped groups of four (4) questions each.

Category 1. Solid Waste Management. According to the Guttman scale, the reproducibility coefficient is obtained, considering that four (4) questions were answered by 30 participants. In this category, 16 errors were identified at random, according to the formula for the reproducibility coefficient (see Ec. 2).

$$CR = 1 - \frac{nº\ de\ errores}{nº\ items * nº de\ sujetos}$$

For this category, the results are as follows:

$$CR = 1 - \frac{16}{4 * 30} = 0{,}87$$

Where 0.87 falls below the acceptable reliability parameter of 0.9 for a strict Guttman scale; this result may be due to the questions in the scaling questionnaire needing to be more specific when inquiring about behavior regarding solid waste and its impact on water resources. The responses reveal an awareness of daily actions concerning these wastes in the urban environment, but do not demonstrate the negative effects of these on the natural water sources of the corregimiento. This suggests, seemingly, a limited awareness of the importance of conserving this environmental factor. However, according to Ansón (1964), who refers to the reproducibility coefficient of this scale with results below 0.9, states that "sometimes weak scales are used, with a reproducibility coefficient ranging from 90 to 80 percent, with errors always distributed at random." Therefore, in the context of this category, although it is "weak," it is a scale which analysis has the potential to provide information about the attitude changes that the sample has undergone

participants are experiencing regarding the environment. We then rely on the result to make the following interpretations:

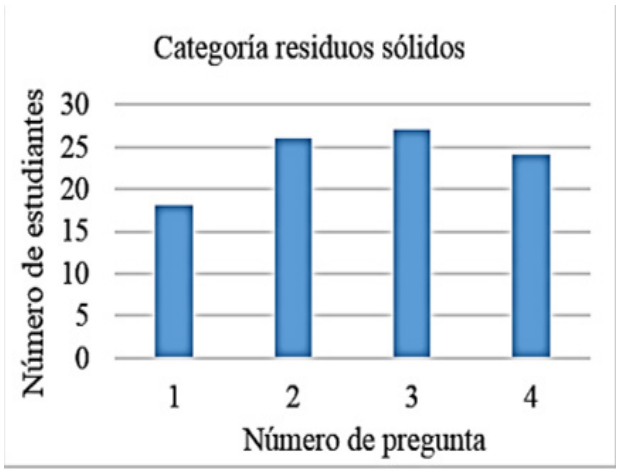

Fig.1 Categoría Residuos sólidos

In this category, out of a total of 30 participants, 11 answered affirmatively to all four (4) questions, 14 answered affirmatively to three (3) of them, four (4) young people agreed to answer "Yes" to two (2) questions, and one (1) agreed to mark affirmatively on only one (1) of the questions. These results are organized in Table IV.

Tabla IV. RESPUESTAS MANEJO DE RESIDUOS SÓLIDOS

Nº de individuos que responden afirmativamente	Cantidad de preguntas
11	4
14	3
4	2
1	1

Fuente: elaboración propia, 2023.

Due to the high tendency to answer affirmatively to 3 or 4 questions in this category, it can be generally observed that there is concern among participants regarding solid waste management in their immediate surroundings. However, there is limited willingness among the group of young researchers to actively engage in its management. This is reflected in the fact that those who responded positively to the act of seeking a container to dispose of the solid waste they produced were represented by a small number.

When comparing this result with those interpreted from the semi-structured interview, there is coherence in their positions, as the majority of young participants argued that "waste on the ground indicates widespread ignorance among residents about the negative consequences of waste on the environment." Similarly, a small number of interviewees stated that they tend to "keep solid waste from manufactured food products in their clothing pockets or bags and then discard it when they find a container along their way" (C1RS).

Category 2. Polluting Effects of Wastewater. According to the Guttman scale, the reproducibility coefficient for this category is:
Reproducibility Coefficient

$$CR = 1 - \frac{12}{4 * 30} = 0{,}9$$

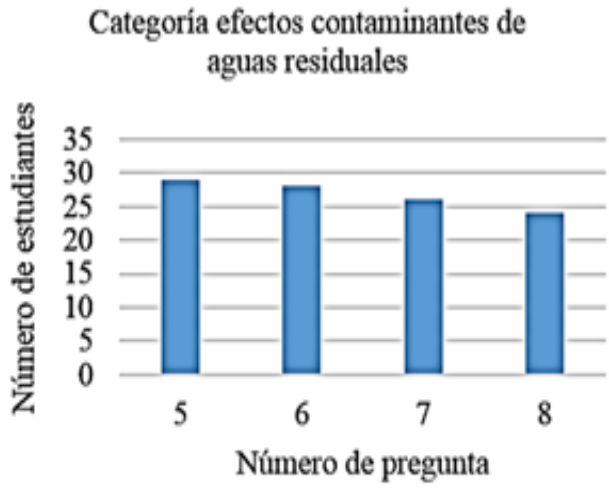

Fig.2 Categoría Efectos contaminantes de aguas residuales

The parameter of the reproducibility coefficient in this category is 0.9, which indicates that it falls within the acceptable reliability limit determined by the Guttman scale. This allows for the interpretation that participants recognize the negative impact on the water quality of the natural bodies that feed the Laguna de La Cocha due to wastewater drainage from homes and animal farms. This, in turn, also affects the wildlife (flora and fauna) of the lagoon ecosystem and, by extension, the health of the residents of El Encano Village. The responses also indicate an awareness that treatment of wastewater drainage could improve the overall health of the residents. The number of affirmative responses provided by them is shown in Table V.

Tabla V. RESPUESTAS EFECTOS CONTAMINANTES AGUAS RESIDUALES

Nº de individuos que responden afirmativamente	Cantidad de preguntas
18	4
11	3
1	2
0	1

Fuente: elaboración propia, 2023.

This result is significant in relation to the general objective of this research, as it highlights how, after developing the IEP focused on recognizing water quality, changes were revealed in the participants' conceptions regarding the water factor in their region. In the semi-structured interview, the majority of them expressed only that "polluting the environment is when garbage is thrown into the streams, causing the water to no longer be pure and making it impossible to drink directly from natural sources, which is why it has to be boiled before consumption" (C1FH). However, they did not mention the idea of wastewater drainage as a primary form of pollution affecting these natural bodies.

1) Category 3. Knowledge of Agrochemical Effects. For this category, the reproducibility coefficient resulted in:

$$CR = 1 - \frac{18}{4 * 30} = 0{,}85 \qquad (5)$$

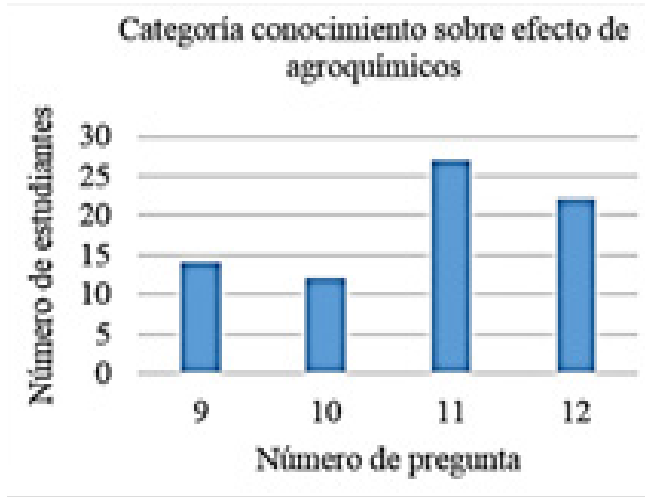

Fig.3 Categoría conocimiento sobre efectos de agroquímicos

Similar to the first category, since it is below the acceptable level of 0.9, it is defined as a scale of weak reliability. However, the score based on the number of affirmative responses given by the student researchers is shown in Table VI.

Tabla VI. RESPUESTAS CONOCIMIENTO EFECTO AGROQUÍMICOS

Nº de individuos que responden afirmativamente	Cantidad de preguntas
5	4
10	3
10	2
5	1

Fuente: elaboración propia, 2023.

It can be inferred that the weak scaling value in this category is due to the limited knowledge that the members of the research group have regarding the negative effects that agrochemicals can cause on water and the environment in general. However, by informing themselves through the questions of the scale about the damage that fertilizers and artificial inputs cause to life in nature and to people in the village, the participant researchers demonstrate concern and adopt a supportive stance toward promoting agricultural practices, such as the use of organic fertilizers and natural pest control methods, to replace the usual use of agrochemicals.

Although the reproducibility coefficient indicates a weak reliability scale, the analysis results in this category show a notable positive change in the attitude of the research group regarding their perception of agrochemical use. When comparing the number of individuals who responded affirmatively on the Guttman scale with the data collected from the semi-structured interview, it is evident that only a minority of interviewees clearly

understood that agrochemicals, due to their toxicity, degrade the quality of arable soil by sterilizing it, negatively affecting pollinators and animal species. Furthermore, they recognized that these products contaminate water, harm the quality of food produced on land, and have impacts on human health (C1DSPA).

Category 4. Wastewater Management. For this category, the reproducibility coefficient resulted in:

$$CR = 1 - \frac{17}{4 * 30} = 0{,}86 \qquad (6)$$

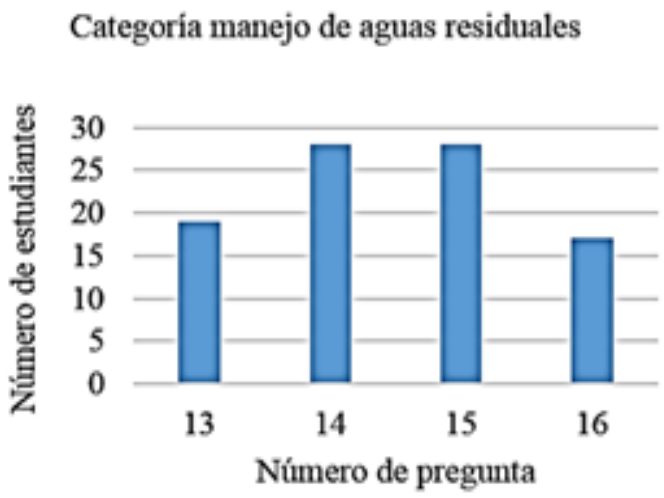

Fig.4 Categoría manejo de aguas residuales

Similar to the first and third categories, this falls below the acceptable level of 0.9, indicating a weak reliability scale. However, the interpretation is made based on the score corresponding to the number of affirmative responses given by the participant researchers, as shown in Table VII.

Tabla VII. RESPUESTAS MANEJO DE AGUAS RESIDUALES

Nº de individuos que responden afirmativamente	Cantidad de preguntas
8	4
16	3
6	2
0	1

Fuente: elaboración propia, 2023.

The weak scaling in this category indicates that, for some participants, it is common for wastewater generated by the normal activities of the community to be discharged untreated into the streams of the district. This demonstrates that this minority group still does not recognize the need to carry out this process as a relevant means to prevent negative impacts on the environment in general.

However, according to the trend in affirmative responses, a majority of the research group is concerned about the fact that the wastewater drained from their homes and district ends up flowing into Laguna de La Cocha, along with the lack of proper management of it. They express their willingness to learn and implement sustainable practices in their homes to treat and recycle wastewater, seeking to reduce the negative impact on the environment. They also recognize that it is the responsibility of each family in the area where they reside to find ways to control the release of wastewater into the rivers and Laguna de La Cocha.

The result of working with the scale reflects a moderately positive change in the students' attitudes toward the environment. Initially, they positioned themselves as distant observers of the phenomenon, attributing the lack of awareness about environmental care to ignorance of ecological processes in the community. They cited, among other factors, indifference toward preventing the discharge of wastewater, pesticides, detergents, and solid waste into the streams. They also mentioned the lack of attention or ignorance regarding the treatment that private companies in the productive sector carry out to prevent contamination of this resource.

However, the number of affirmative responses in this category indicates that among those who participated in the research, there is an individual conviction that reflects committed stances to address situations that negatively impact the natural bodies of water in the village.

2. Category 5. Conservation Attitudes. For this category, the reproducibility coefficient resulted in:

$$CR = 1 - \frac{18}{4 * 30} = 0{,}85 \qquad (7)$$

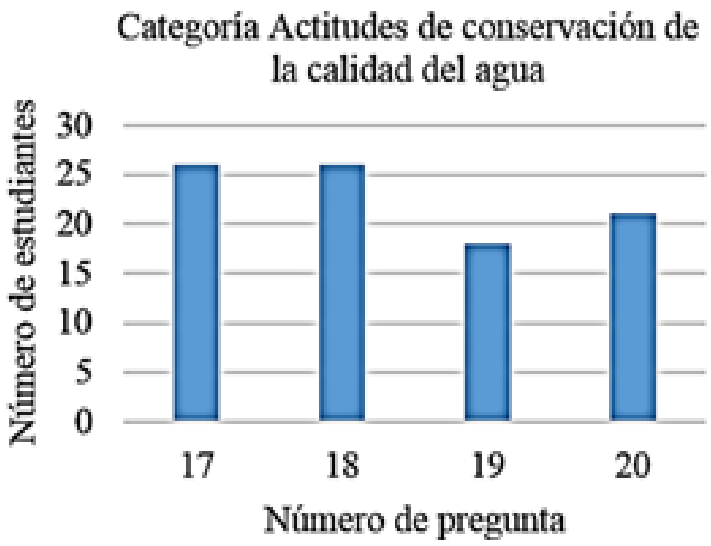

Fig.5 Categoría actitudes de conservación de la calidad del agua

Despite having a weak reliability scaling, the analysis is conducted based on the values of affirmative responses provided by the participants in the research group, as expressed in table VIII.

Tabla VIII. RESPUESTAS ACTITUDES DE CONSERVACIÓN

N° de individuos que responden afirmativamente	Cantidad de preguntas
13	4
9	3
4	2
4	1

Fuente: elaboración propia, 2023.

The scores below the acceptable level may not necessarily be due to weak environmental awareness, but rather to the limited leadership willingness among some members of the research group to share their insights gained during the investigation into water resource conservation in the area. The trend of affirmative responses indicates that participants, individually, feel motivated to engage in actions aimed at caring for and conserving water, expressing their readiness to adopt personal measures to reduce water pollution in their region. They reinforce this idea by considering that each individual has the responsibility to preserve and protect water for the benefit of their community and the environment through their daily actions.

However, in response to the proposal to gain more knowledge about water conservation and to share that information with their peers and people in their neighborhood through awareness campaigns or community activities, just over half of the group showed interest.

They express their willingness. This stance remains consistent when compared to the results of the semi-structured interview, where, in response to questions related to the environmental culture exhibited by the people of El Encano, there was no argument that referenced community work focused on protecting the environment.

However, even though the willingness to engage in community environmental awareness work is present in just over half of the group of young participants, this can be interpreted as a positive start towards greater environmental awareness and collaboration within the community.

Category 6. Attitudes in Favor of Water Conservation. The reproducibility coefficient in this category was

$$CR = 1 - \frac{24}{4 * 30} = 0{,}8 \qquad (8)$$

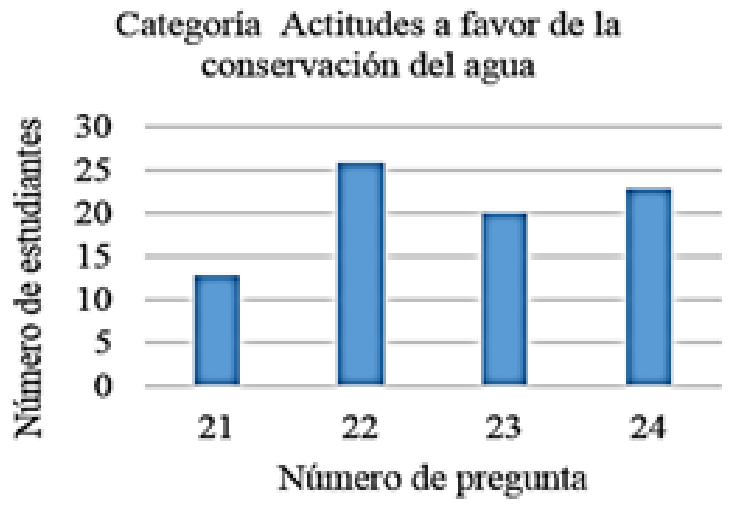

Fig.6 Categoría actitudes a favor de la conservación del agua

The value of the reproducibility coefficient is the lowest among those obtained in the work with the Guttman scale across the eight categories; however, the reliability falls within the range of a weak scale and, according to the criteria used for the analysis, offers valid results.

In this case, one reason may be that there is a scaling error and the content of the first question should have been focused as an argument encompassing the validation of the other three, placing it in fourth position in the group. This is because, according to the trend of affirmative responses in this category (Table IX), when community labors are held in their neighborhoods to carry out reforestation and cleaning tasks for paths and streams, just under half of the participants claim to actively participate.

Tabla IX. RESPUESTAS ACTITUDES A FAVOR DE LA CONSERVACIÓN DEL AGUA

N° de individuos que responden afirmativamente	Cantidad de preguntas
6	4
13	3
8	2
3	1

Fuente: elaboración propia, 2023.

An explanation for this result can be found in the responses obtained during the semi-structured interview. In these responses, it was mentioned that "in some areas, people who cut trees replant seedlings of the pruned species, while in other areas, they occasionally hold community labors for the maintenance of productive agricultural sectors" (C2APCF), suggesting that initiatives by the residents of the district to engage in these collective participation practices in favor of the environment are not common occurrences. This may explain why, for the most part, they claim not to participate in such activities, as they appear to be infrequent in the El Encano district.

However, the majority of the group of young researchers considers it necessary to conduct prior motivation among the neighbors of the neighborhoods before carrying out community labors and conservation activities for the rivers and streams to ensure their active participation. Additionally, a significant majority of them express their willingness to motivate and encourage neighbors to get involved in community labors, thus working together for the well-being of the rivers and streams in the area. Similarly, the group of young individuals is clear that one way to positively change the neighbors' attitude towards environmental conservation, especially regarding water, is through community labors that promote the preservation of the natural environment and sustainable development in their village.

2) Category 7. Commitment to Water Conservation. For this category, the reproducibility coefficient was:

$$CR = 1 - \frac{16}{4 * 30} = 0{,}87 \qquad (9)$$

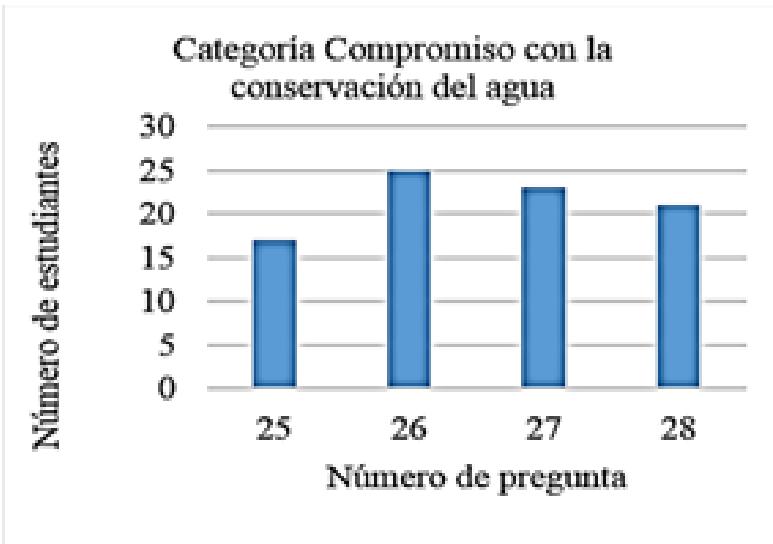

Fig.7 Categoría compromiso con la conservación del agua

The marking of affirmative responses is shown in Table X

Tabla X. RESPUESTAS COMPROMISO CON LA CONSERVACIÓN DEL AGUA

Nº de individuos que responden afirmativamente	Cantidad de preguntas
12	4
9	3
4	2
3	1

Fuente: elaboración propia, 2023.

In this category, the majority of participants state that they are willing to provide voluntary assistance if asked to participate in a campaign for the cleaning and maintenance of the rivers and streams in El Encano. A similar number of participants express their willingness to invest part of their free time in learning more about the consequences of water pollution and contributing to the protection of the rivers in the district. A majority, although slightly less than the previous groups, indicate that they would participate in educational activities such as garbage collection at La Cocha lagoon and cleaning the beds of trout breeding sites, in order to avoid possible sanctions from the Ministry of Environment for residents of their neighborhoods.

However, the value of the coefficient within a weak scaling in this category could again be attributed to the limited leadership willingness to motivate others to participate in a collective effort in favor of the environment, especially concerning water resources. Here, just over half of the researchers responded affirmatively to the question: "Would you be willing to dedicate part of your free time to inform others, such as family and friends, about the importance of protecting and conserving the rivers and streams in El Encano?"

This result aligns with the conclusions obtained from the semi-structured interview, where it is mentioned that residents and business owners are concerned about conserving the flora and water of El Encano; it is argued that the fact that this attitude is shared by a minority suggests that the population, in general, has an emerging culture regarding environmental care, which needs to be strengthened to promote conservation.

3) Category 8. Participation in the PRAE. In this category, the reproducibility coefficient falls within the acceptable reliability range of the Guttman scale:

$$CR = 1 - \frac{6}{4 * 30} = 0{,}95 \qquad (10)$$

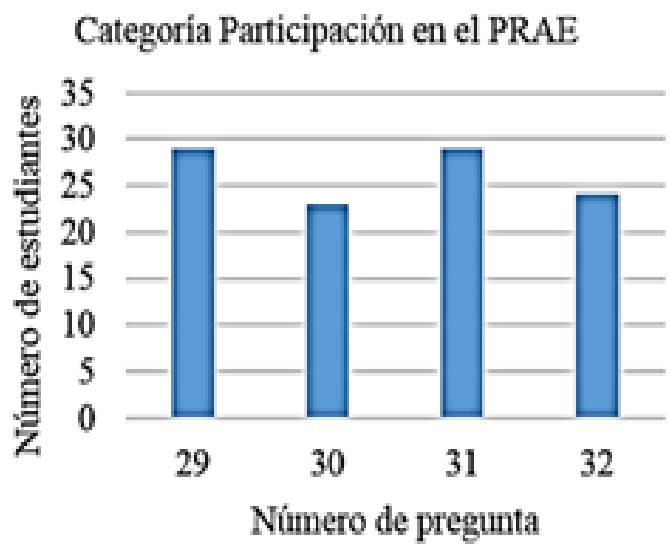

Fig.8 Categoría participación en el PRAE

It can be associated with the affirmative responses of the group of questions in this category, as shown in Table XI.

Tabla XI. RESPUESTAS PARTICIPACIÓN EN EL PRAE

Nº de individuos que responden afirmativamente	Cantidad de preguntas
20	4
6	3
3	2
1	1

Fuente: elaboración propia, 2023.

It is noticed that the result approaches the ideal level of reliability; therefore, a high assertiveness can be recognized in the meaning of the responses related to their participation in the Environmental School Project (PRAE) of IEM El Encano.

Through their experience in the research work on water, the majority of participants recognize the purpose or objective of the institutional PRAE, which aims to strengthen participants' awareness of conservation and care for the environment, especially regarding water resources. Similarly, they believe that valuable life lessons can be learned by participating in school activities aimed at protecting the ecosystem of "La Cocha lagoon", particularly the water.

In a smaller percentage, yet still a majority, the group of participants expresses feeling motivated to continue participating in events or actions promoted by the PRAE of the institution. Additionally, they express their willingness to actively participate from school in implementing initiatives in favor of the natural environment (vegetation, wildlife, water, soil) in El Encano village.

The results in this category indicate a strengthening of the stance that participants displayed initially, when, in general, their responses to the semi-structured interview argued that "the education received in school leads them to act spontaneously in the appropriate use of water, recycling used batteries, making crafts with plastic solid waste, giving a second use to plastic containers, and producing compost with homemade organic waste" (C4APFA).

IV. CONCLUSIONS

After developing the IEP, noticeable changes are evident in the perceptions of the participant researchers at IEM El Encano regarding the water resource in their region, leading them from a basic understanding they had at the beginning about water pollution to recognizing the common anthropogenic actions that significantly negatively affect it.

The transformation in the perceptions achieved by the participant researchers through the adaptation of the IEP to address the importance of the water resource and environmental awareness suggests a positive effect on attitude change. This is reflected in their demonstrated potential to strengthen personal knowledge and attitudes related to water conservation and their contribution to environmental sustainability.

By highlighting the importance of implementing effective measures at both the individual and community levels for the treatment of wastewater as a means of protecting both the surrounding environment and the health of the population in El Encano village, a deeper commitment to the protection of water and the natural environment is evident. This change also reveals a strengthening of environmental awareness, as it recognizes the complex interconnection between water quality, the ecosystem, and human health in their perceptions.

The willingness to engage in community environmental awareness work regarding water resources was evident in just over half of the group of young students; however, this can be considered an encouraging starting point towards a stronger environmental awareness and broader collaboration within the community. Nevertheless, it raises significant concerns to identify and understand the re-

asons behind the limited leadership willingness of some students to address obstacles and find effective ways to communicate the importance of water conservation and the vital role each individual can play in this effort. Thus, it becomes a challenge to identify and understand the reasons for this personal disposition, which could trigger new research motives.

However, the methodological approach of the IEP shows weaknesses in terms of the intended global reach. It was expected that, by implicitly addressing the water aspect—which is intertwined with environmental dynamics—the changes in participant attitudes resulting from this methodological strategy would extend to other environmental factors in general, such as flora, fauna, and soil. However, only observable changes were noted in the water factor, which is the subject of this study, with minimal changes in participant attitudes towards other variables impacting various components of the natural environment, such as solid waste management to prevent pollution of natural water bodies, among others.

The participant researchers tend to maintain inadequate attitudes towards solid waste management, due to entrenched habits formed in their homes and social contexts. Although proper solid waste management at IEM El Encano has been carried out in the presence of teachers—who represent an authority figure and somewhat condition this behavior—genuine changes towards positive behavior are scarce. This includes properly disposing of a piece of discarded paper and avoiding contamination of the environment. Such a situation is similar to the perceptions that participants expressed from the beginning, indicating that there has been no positive attitude change regarding the environment in this aspect.

With the development of the IEP, in relation to the Environmental School Project (PRAE), it is evident that several of the learnings achieved at school within this project are spontaneously applied in their daily lives, being only one perspective of the research group, not of the entire participant community. However, it is revealed that the concept participants have about the reach of the PRAE includes motivation for environmentally benign actions such as recycling, reusing non-biodegradable waste materials, or disposing of solid waste in appropriate containers while at school; such practices are validated.

As attitudes that represent a firm environmental consciousness, there are no active positions involved in the sustainable management of natural resources or commitments to questioning and denouncing negative environmental impacts such as deforestation and water pollution.

Although encouraging results were achieved with the application of the IEP, it is important to recognize that environmental education is an interdisciplinary process that involves the participation of all areas of knowledge, along with the engagement of the educational community as a whole within the school environment. Furthermore, this process requires consistency, and its success depends on various interrelated factors such as family, culture, socioeconomic conditions, and the media. These are influential factors that, in the pursuit of authentic positive attitude changes that demonstrate sustainable strengthening of environmental consciousness over time, must operate in coordination toward shared collective objectives, setting aside individual and egocentric approaches.

V. RECOMMENDATIONS

Research in environmental education generates knowledge and strengthens awareness for the sustainable conservation of the environment among participants. However, its impact can be even broader in society if the strategy is conceived as a continuous process capable of influencing decision-making and the adoption of more responsible practices concerning water and the environment.

Future research within the framework of environmental education could focus on exploring the authenticity and long-term sustainability of the attitudes and knowledge acquired during the development of this thesis by the participant researchers, and how these can translate into concrete actions in their daily lives.

As a cross-cutting project, the influence of the PRAE could be more significant if adopted in its literal sense. Following this idea, the areas of knowledge, families, the educational community, and social, civic, and community organizations involved in the institutional environment should collaborate towards a shared environmental goal. Until this occurs, the actions promoted by the Environmental School Project in favor of the environment will be marginal or dismissed due to the influence of particular interests, whether economic, cultural, territorial, or political.

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