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TRAINING PROJECT FOR THE DEVELOPMENT OF RESEARCH SKILLS IN NATURAL SCIENCES IN ECUADORIAN HIGH SCHOOL STUDENTS

PROYECTO FORMATIVO PARA EL DESARROLLO DE HABILIDADES INVESTIGATIVAS EN CIENCIAS NATURALES EN ESTUDIANTES DEL BACHILLERATO ECUATORIANO

Elizabeth Natali Martínez Martínez[a]
Alfonso Laso Bermeo, Ecuador
(enatali20253@gmail.com) (https://orcid.org/0009-0006-9900-5056)
Selena Hernández Benítez
Alfonso Laso Bermeo, Ecuador
(selenahb26@gmail.com) (https://orcid.org/0009-0008-7957-7270)
Betty Dalila Sinaluiza Vichisela
Alfonso Laso Bermeo, Ecuador
(bettysinaluisa.1895@gmail.com) (https://orcid.org/0009-0008-6502-3541)
Patricia Cecilia Jiménez Guananga
Alfonso Laso Bermeo, Ecuador
(patriciajimenez1304@gmail.com) (https://orcid.org/0000-0002-6775-4881)
Dayami Álvarez Ayala
ACAI-Center, Ecuador
(alvarezayaladayami@gmail.com) (https://orcid.org/0000-0002-4622-0274)

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ABSTRACT

The scientific formation of students, regardless of their particular educational level, is a requirement in most countries. Educational systems declare the need to work on research, some as a curricular requirement and others as a need within comprehensive training, but worked extracurricularly. In the case of Ecuador, the regulatory documents of the unified general baccalaureate declare the scientific and integral formation of students in different spaces, despite the fact that educational practices are not always prosecuted towards these claims. In this article, the result of a research that proposes the treatment of formative research from the structuring of a project in the area of natural sciences, is exposed at the baccalaureate level of an educational unit; where the integration of materials, spaces and relationships with the socioeconomic and natural environment are essential. The research carried out is interesting, as it bets on the reflective and self-reflexive character, both individual and group, typical of qualitative research; despite the quantitative logic that prevails in the structure of the proposed project. The consensus criteria of experts and participants in the structuring, allow to assert the significance and sufficiency of the project for the development of

[a] Corresponding author.

investigative skills in students, and the required scientific and technological learning.

RESUMEN

Palabras clave:
investigación formativa, proyecto, Ciencias Naturales, Bachillerato

La formación científica de los estudiantes, independientemente del nivel educativo particular, constituye una exigencia en la mayoría de los países. Los sistemas educacionales declaran la necesidad de trabajar la investigación, algunos como exigencia curricular y otros como necesidad dentro de la formación integral, pero trabajada extracurricularmente. En el caso de Ecuador, los documentos reglamentarios del Bachillerato General Unificado, declaran la formación científica e integral de los estudiantes en diferentes espacios, a pesar de que las prácticas educativas no siempre se encausan hacia esas pretensiones. En el presente artículo, se expone el resultado de una investigación que propone el tratamiento a la investigación formativa desde la estructuración de un proyecto en el área de las Ciencias Naturales, en el nivel de Bachillerato de una Unidad Educativa; donde la integración de materias, de espacios y las relaciones con el entorno socioeconómico y natural resultan esenciales. La investigación desarrollada resulta interesante, al apostar por el carácter reflexivo y autorreflexivo, tanto individual como grupal, propio de la investigación cualitativa; a pesar de la lógica cuantitativa que prevalece en la estructura del proyecto que se propone. El criterio consensuado de expertos y participantes en la estructuración, permiten aseverar la significatividad y suficiencia de proyecto para el desarrollo de habilidades investigativas en los estudiantes, y el aprendizaje científico y tecnológico exigido.

Introduction

In the current educational context, it is of vital importance that Ecuadorian high school students acquire research skills in the natural sciences. These skills will enable them to develop critical and reflective thinking, as well as to successfully face the academic and work challenges of high school. In addition, research training has become an imperative need due to the rapid technological advancement and innovation that characterizes our world today.

The term "ability" is closely linked to the development of habits, skills and mental processes that enable individuals to be competent in the challenges that society presents to them in their lives. Current education seeks to promote the development of research skills through both dependent and independent exploration of knowledge. This allows to promote the capabilities and improve the performance of people in their environment.

Considering the current demands of the labor market and the preparation of high school graduates to face the upper secondary level, it is essential that they possess knowledge and attitudes related to research training. This will allow them to access better job opportunities and succeed in their university career according to the accelerated process of innovation and technology that we are experiencing today.

Through a training project, we seek to foster the development of critical and reflective thinking in students by providing them with practical experiences where they can apply their theoretical knowledge in real situations. In addition, it is intended to promote the analysis, synthesis and generalization of data and results obtained during the research. This project not only strengthens experimental competencies within the educational environment, but also establishes links between formal education and society. In this way, it is possible to contextualize the issues addressed by the students with the current needs of our society.

It is important to emphasize that the formation of habits, skills and abilities during general education and high school studies is a fundamental basis for enhancing academic performance in more demanding university environments. In these environments, research plays a crucial role in developing the competencies needed to work in various professional areas. The development of critical thinking and research practice in high school students provides a systematic structure to efficiently develop the required research skills.

The high school level in Ecuador, as the third level of school education, is characterized by the complementarity and interdisciplinary integration of the education received, preparing students for their continuation in higher education. In this sense, the importance of promoting innovation, understanding development and its limitations, working with chemical, physical and biological processes, as well as incorporating scientific and technological advances is recognized.

Emphasis is placed on the need to train students to make decisions in the face of complex environmental and cultural problems. As established in the programmatic documents, it is necessary for students to develop research skills through field work and experimentation as a basis for logical and critical arguments. Therefore, an education that fosters the integration of knowledge and applies scientific research methods to transform reality is increasingly crucial.

In relation to the latter, it is argued that the use of projects based on real local problems should be the main training mechanism in research for high school students. These problems may be identified by the students or teachers themselves during field work or presented by the latter based on previous exploratory research. The investigative

capacity is a personal process that allows reaching advanced levels coinciding with the acquired knowledge. It is important to determine specific areas in which to design strategies that help strengthen the students' research skills as a support for their self-training.

This issue is closely related to subjects in the area of Natural Sciences, which raises the opportunity to involve students and teachers in research on soil composition and the use of nanomaterials to improve local agriculture. The question then arises as to how to achieve active participation by students in these investigations.

The main objective of this article is to present a training project specifically designed to enhance research skills in Natural Sciences among Ecuadorian high school students. This project seeks to connect students with their environment and community, giving them the opportunity to address real problems related to this scientific discipline. The specific objectives are to describe a formative research project involving both students and teachers in the area of Natural Sciences at the Alfonso Laso Bermeo Educational Unit, located in Quito, Ecuador, and to structure the project in order to promote student protagonism and achieve an integral education.

Thus, this article aims to contribute to the educational field by presenting an innovative educational project that promotes the development of research skills in Natural Sciences among Ecuadorian high school students. It is hoped that the results obtained will serve as a solid basis for implementing similar strategies to promote academic success and comprehensive training in this relevant scientific area.

Research training is understood as a process that involves diverse actors and practices. Trainers, as human mediators, have the role of promoting and facilitating access to knowledge, the development of skills, habits and attitudes, as well as the internalization of values necessary to carry out research practice.

It is important to note that this training is not limited to a defined period of time. It is not simply a matter of completing training before conducting research. Research training also occurs during the research process itself and throughout the time an individual is a learner both inside and outside the school system.

Research training may have different emphases and use various procedures depending on the fundamental objective guiding such training. It is different to provide training oriented towards those who will dedicate their professional life to research (researcher training) than to offer it to those who need to improve their professional performance or apply research results in their field of work. There is also a form of training focused on developing mental structures and general skills to solve problems and achieve better results in everyday aspects. In other words, research training is a continuous and intentional process that involves different phases and objectives according to the specific needs of the subjects involved.

The training of researchers is a broad process that focuses on preparing individuals to perform professionally in the generation of knowledge in a specific field. This process has both a personal and institutional dimension, and is not limited only to formal educational programs. In addition, it is not subject to a specific time frame or unique modalities.

In the strictest sense, research training involves the preparation of people who seek to engage professionally in research. Several authors recognize the formative value of research for university students. For example, Vallejo et al. (2020), López et al. (2021), Sánchez y Murillo (2021), Pensado et al. (2022) y Espinoza (2022) have highlighted the difficulties students face when entering university and how research can provide them with scientific methods to construct knowledge for themselves, beyond just appropriating research results conducted by others.

Casanova (2020) argues that, before developing research skills in students, it is essential to form a system of attitudes based on affectivity and love for inquiry. This training should begin at the basic levels of education and continue through higher education. It also emphasizes that this comprehensive training must adopt a systemic approach. In this sense, Casanova (2020) states that the skills to be enhanced are: obtaining, processing and communicating information through research actions as a means to achieve academic objectives.

Blanco et al. (2019) point out that students' formative processes should be approached from a reflective and updated didactic perspective. It is necessary to prepare students to search for relevant information, process it properly and communicate results and conclusions using the scientific method. To achieve this, aspects related to health, family, environment and the community surrounding the students must be considered. The didactic processes for developing research skills must include both the planning and execution of such processes. In addition, Zambrano et al. (2022) suggest exploring new ways to enhance research skills so that students can become actively involved by searching for information on topics that are relevant and interesting to them.

Based on the premise that technological support is important nowadays, since it fascinates students and immerses them in a world of triple coding (sound, color and movement), it can be stated that these technological resources are motivating and attractive to students, which facilitates better academic performance and allows them to develop their capabilities (Miranda et al., 2020).

In relation to the development of research skills, Miranda et al. (2020) explain that students often face difficulties due to the need not only to understand the problem, but also to intervene to enhance skills related to information search, processing and communication.

At the baccalaureate level of education, research is considered to be a completely didactic and interactive process. During its application, students actively participate by appropriating and constructing their own knowledge through individual practice, group learning and discovery. It is in this context that innovative attitudes towards science and technology are fostered (Castro et al., 2019).

It is evident that both students and teachers face problems, since they do not always address real issues that can be converted into needs felt by society and, as a consequence, by the students themselves. These inconsistencies become more noticeable upon entering college.

Several studies confirm the problem that students experience when they move from high school to college in terms of their research habits. The teaching provided by high school teachers is deficient and most students lack the motivation to research and develop projects. There is a tendency toward passively receiving information from the teacher rather than being actively involved in carrying out projects (Castro et al., 2019).

According to Zúñiga et al. (2023), "an effective strategy to foster research skills in high school students is the realization of formative projects, which allow them to engage with their communities in real scenarios" (p. 1218). These projects facilitate the development of cognitive skills, such as critical and reflective thinking, as they are directly related to the project being developed. Students have the opportunity to perform analysis, synthesis and generalizations from data and results, as well as explore different literatures and phenomena to draw a line of inquiry focused on their research objectives.

In this sense, formative research involves acquiring a set of knowledge, skills, abilities and attitudes necessary to carry out research processes (García et al., 2018). It is essential that these qualities be cultivated from high school to promote a general culture among students that can be efficiently applied in higher education. As students are

confronted with increasingly complex research tasks during their academic training, they will be better prepared to develop the skills necessary for future research projects.

The participation of students in formative projects provides them with the opportunity to directly explore specific topics, such as monographs, which allows them to construct their own learning and develop a progressive research culture. According to Díaz et al. (2021)the use of the classroom project as a formative research strategy has made it possible to recreate cases within the educational environment and to achieve an integral concreteness of the teaching-learning process" (p. 11). This practice not only fosters an investigative culture among students, but also contributes to their integral formation as they face diverse educational processes.

In a scientific study conducted by Martínez (2019)a problem related to soil composition and its possible influence on local agriculture was identified. It became evident that indiscriminate agricultural practices can cause significant wear and tear on soils, especially in the midst of the global climate crisis. For this reason, there has been increasing interest in using smart materials produced from sustainable and inexhaustible reservoirs, such as naturally degradable carbon, that are less toxic and do not rely on fossil resources. In this context, the feasibility of biomaterials derived from naturally available raw materials has been studied, with emphasis on biopolymers obtained from biomass (Martinez, 2019).

Project-based learning, working with formative research in different contexts and Natural Science studies related to Chemistry and agriculture have been addressed by several authors. Among them are Castro et al. (2019), Espinoza (2020), Guerra et al. (2021), Carrillo et al. (2021), Yera et al. (2021), Zúñiga et al. (2023) y García (2023). These authors justify and suggest the importance of conducting research and developing projects for training purposes.

Method

The research conducted is based on the dialectical and socio-critical paradigm, which recognizes the development and self-development of the objects of reality through the contradictions that generate them. In addition, it is argued that the construction of knowledge is a self-reflective process that arises from the socio-individual needs of the groups, which drives the development of its members' capabilities. In this sense, the predominant approach used in this research is qualitative.

Theoretical methods such as analysis and synthesis were used to address the problem and determine the theoretical foundations, as well as to process the information presented. Inductive and deductive methods were used to study particular cases and generalizations derived from the study of soils and proposals related to agricultural problems and the use of nanomaterials.

The content analysis method was used to identify the essential categories and subcategories related to the conception of formative projects and research skills. This identification was carried out by reviewing scientific articles published in indexed journals, theses and books in recognized databases.

The Expert Criteria method was used to evaluate the feasibility, adequacy and relevance of the proposed training project. In this process, 10 experts were selected after calculating the competence coefficients on knowledge in educational projects and research skills, using a potential sample of 16 experts.

Once the experts were selected, the training project proposal was sent to them by email and WhatsApp, accompanied by a survey containing dichotomous questions. The

reliability of this instrument was evaluated by calculating Cronbach's Alpha coefficient using SPSS version 25 software. A value of 0.93 was obtained, which indicates a high internal consistency of the responses obtained from the experts.

In addition, SPSS version 25 was used as a statistical tool for the analysis of the instruments used in the survey. This tool made it possible to evaluate the reliability and validity of the data collected, as well as to identify possible patterns or trends in the experts' responses.

Thus, the Expert Criteria method, together with the calculation of Cronbach's Alpha coefficient using SPSS version 25 and the use of statistical tools for the analysis of the instruments, allowed a rigorous and reliable evaluation of the viability and relevance of the proposed training project.

The selection initially considered professional and ethical qualities, as well as academic or scientific level, in addition to their willingness to participate in the process. The target population included specialists involved in executive studies or formative and research processes within the educational field.

A coefficient of expertise was calculated based on their knowledge and the sources available to obtain it. Finally, 10 experts were selected: six with a medium-high coefficient and four with a high coefficient.

In order to determine the criteria for assessing the relevance, adequacy and potential viability of the structured project, the experts were provided with a detailed summary of the project components along with an explanation of how the project was constructed. A permanent exchange was maintained with the experts and the individual assessments were summarized until a consensus or favorable majority was reached.

Results

As an initial result, a formative project proposal has been developed to foster the research skills of high school students. This proposal seeks to promote learning through research. Although this educational approach has been conceived mainly in Higher Education institutions, the idea is defended that it is also possible to implement it at different educational levels.

Projects are considered to be mechanisms both for managing research in general and for promoting research training specifically. A research project is a structured and feasible objective that arises from an individual or common need among a group of people. Their resolution requires a scientific process to be carried out within the established time frame and with the appropriate human, material and financial resources.

If the project has a formative intention, then it must integrate two objectives: the formative and the investigative. These may coincide when the problem to be investigated is related to a specific formative aspect. In this proposal structured in this article, the formative intention directed to students of the third year of the General Unified High School in the Alfonso Laso Bermeo Educational Unit located in Quito, Ecuador, is integrated. The basic problem addressed is related to local agricultural development.

It is essential to involve students, teachers in charge of subjects related to Natural Sciences and community agricultural actors to jointly build this research-training project. In this way, learning in the classroom is combined with outdoor educational activities, as established by Ecuadorian regulations.

The training of the students must be in line with the methodology used in the structuring of the training project presented. This methodology consists of several steps:

Identification and argumentation of the basic problem: Identification should preferably take place in the natural context, where there are real perceived needs. Argumentation, on the other hand, can be developed from both theory and practice, covering different contexts or spaces. This involves time and dedication, but it also requires the participation of everyone involved. In this specific case, we consider those who feel the need and those who have the desire and capacity to satisfy it. Students and teachers related to the areas of knowledge of Natural Sciences are also directly involved.

On this particular occasion, a problem previously identified by the main author in previous research is used to proceed to find the necessary and sufficient arguments. It is important to bear in mind that students do not always have the knowledge required to address these issues, and often these topics are not even included in the programs or curricula of the corresponding subjects. Therefore, it is necessary to generate additional training to broaden the existing curricular contents, always relating them to the problems raised.

To carry out this identification of specific problems, a real case is used, located in Agrícola Jiménez in the canton of La Maná in the province of Cotopaxi. In this particular case, there is a problematic situation related to the soil in the area. La Maná is located on a plain in the western Andes Mountain range, about 150 km from the provincial capital, Latacunga. The canton's name is associated with the fertility of its soils, which are suitable for any type of crop.

The research seeks to investigate soil composition and how it influences agricultural performance, not only from a quantitative point of view but also from an environmentally sustainable perspective. To achieve this, it is necessary to systematize information related to soils, their composition and their influence on agriculture.

The search for and systematization of information for the theoretical argumentation: is carried out by the participants involved, especially the students and teachers of the Natural Sciences area. A guide with the thematic contents is provided and the necessary time is allocated to search and summarize the information. In addition, the form in which it will be presented is determined.

Among the topics to be addressed are: definition and classification of soils, characterization of agro-productive soils, identification of microflora and fauna existing in the soil, implementation of new technologies for soil conservation and improvement of soil quality. It is essential to promote the active participation of all those involved, especially students and teachers related to the subjects of the Natural Sciences area.

Table 1 shows a structured example of how to search for information on the specific topic "soils and soil improvement". This table serves as a reference within the proposed training project, providing support to high school students to develop research skills such as search and adequate systematization of information necessary to support their theoretical arguments.

Table 1
Structuring the search for information on soils and their improvement

Problem investigated.	Topics of study for its foundation.	Author's references (proposed by Martinez (2019))	Study participants.
Possible influence of soil composition on agricultural performance.	Soil definition and classification. Characterization of soils and agro-productive soils. Possible existing microflora and fauna depending on the soil. Implementation of new technologies for soil conservation. Improving soil quality.	Maurya et al. (2020), De Deyn and Kooistra (2021), Bernal et al. (2015), Basak et al. (2021), De Deyn and Kooistra (2021), Javed et al. (2021), Saeed et al. (2021), Sharma et al. (2021)	Students of the three years of high school and teachers of Natural Sciences.
Presentation of systematized information.			

From the systematization, it is concluded that there are carbonaceous nanomaterials in the soils of the area that could be affecting agricultural yields. Therefore, it is necessary to conduct a search to collect and organize information related to this issue. Based on this, a research question is posed: what evidence supports the improvement of agro-productive soil yields through the inclusion of carbonaceous nanomaterials obtained by hydrothermal synthesis of biomass?

In order to carry out this informative search and obtain a theoretical basis to answer this question, it is necessary to delve into new topics within different areas of knowledge, involving both students and professors.

Table 2 below shows how to structure and organize the specific search on the new topics addressed, such as nanomaterials and carbonaceous nanoparticles. This will help in the development of research skills in students, especially in terms of the ability to search for relevant information.

Table 2

Structuring the search for information on carbonaceous nanomaterials and nanoparticles

Problem investigated.	Topics of study for its foundation.	Author's references (proposed by Martinez, E. N. (2019))	Study participants.
Possible enhancement of the performance of agro-productive soils with the inclusion of carbonaceous nanomaterials obtained by hydrothermal synthesis of biomass	Superabsorbent materials. Natural sources of production. Artificial procurement methods. Physicochemical properties of superabsorbent materials. Regulations for the use of superabsorbent materials. Nanoparticles. Natural sources of nanoparticles. Physicochemical properties of nanoparticles. Nanoparticle characterization techniques. Methods of nanoparticle preservation. Carbonaceous nanomaterials. Chemical Structure. Physical-chemical properties. Applicable concentrations of carbonaceous nanomaterials to soil.	Cuadri et al. (2017), Llanes et al. (2020), Ucar (2020), Ucar (2020), Cordobés et al. (2016), Vasconcelos (2016), Yea et al. (2016), Ostrand et al. (2020), Dutkiewicz (2002), Gao et al. (2018), Olad et al. (2020), Zhang et al. (2021), Mignon et al. (2019), Zohuriaan-mehr and Kabiri (2008), Meshram et al. (2020), Behera and Mahanwar (2020), Rupert (2018), Kumar and Kumar (2017), Maduraiveeran and Jin (2021)	Students of the three years of high school and teachers of Natural Sciences.
Presentation of systematized information.			

In order to carry out the practical argument, it is identified that an experimental type of research is required. This type of research involves the manipulation of variables in order to observe, determine or measure responses or effects on other variables. In terms of approach, the quantitative approach will predominate, involving measurements and analysis of data crucial to answering the defined question.

Based on the above, the following questions arise:

- where can the data be obtained from?
- where are the relevant sources located?
- what methods, procedures and techniques can be used to collect the necessary data?
- Once the data have been collected, how should they be prepared for further analysis?

Based on the theoretical and practical analysis carried out up to this point, it is possible to determine the main activities to be carried out together with their respective indicators. In addition, the time needed to execute these activities and the resources required must be established.

The activities are determined according to each objective, taking into account the participants involved, the time required and the indicators to measure compliance. A Gantt chart and a logical framework matrix can be used to facilitate this step.

The following are some of the proposed activities:

Identification of laboratories for the study: It is suggested that soil investigation be carried out in specialized laboratories, such as the Laboratory of the Engineering and Applied Sciences Group (GICAS) located at the Universidad San Francisco de Quito, Quito canton, Pichincha province.

Determination of reagents and other resources: Participants will identify the following reagents required: raw material (banana peel dehydrated for 72 hours), distilled water and citric acid. In addition, equipment such as a hydrothermal reactor, precision furnace and filtration equipment (suction pump, filtration funnel and filter paper) will be required.

- Establishment of the appropriate sequence to perform the measurements.
- Systematic and accurate collection of data related to the study.
- Careful and comprehensive processing of the complete set of information collected.
- Comprehensive assessment and interpretation based on the information gathered together with clear and coherent presentation of the results obtained.
- Prepare detailed reports that allow sharing the findings with others interested or involved in the research topic
- Critically evaluate the entire structured project considering the objectives set, the activities carried out and the results obtained.

It should be noted that these are only some of the possible activities to be considered.

Regarding the evaluation of the training project proposal to develop research skills in high school students, an evaluation was carried out by experts using the Delphi method. The results obtained indicate that the experts considered the project to be relevant, sufficient and feasible in its dual function: to address the basic research problem and to foster the development of research skills in students.

In addition, the experts emphasized that the project has a methodological structure with a logical sequence. This structure facilitates students to acquire the necessary skills to face real problem situations in diverse contexts. It was also noted that the project prepares high school students to solve problems related to the natural sciences through scientific research. This aspect positively influences the integral formation of the students.

It is important to emphasize that these comments highlight some key aspects identified by the experts during their evaluation. Their opinions support both the relevance and feasibility of the proposed training project, as well as its potential impact on the development of research skills and general educational enrichment of the students involved.

In the study on the formative project for the development of research skills in Natural Sciences in Ecuadorian high school students, an evaluation was carried out both before and after the acquisition of these skills. The main objective of this evaluation was to measure the impact of the project on the development of students' research skills.

Prior to the implementation of the project, an initial assessment was conducted to establish the level of research skills of the students. This was done through tests and activities that assessed their ability to formulate research questions, design experiments, collect and analyze data, and communicate results effectively. These initial evaluations provided a baseline to compare results after project implementation.

Once the formative project was carried out, a second evaluation was conducted to measure the students' progress in the development of their research skills. Tests and activities similar to those used in the initial evaluation were applied, which made it

possible to compare the results and determine if there were significant improvements in the students' research skills.

In addition to individual evaluations, qualitative data were also collected through observations and interviews with participating students and teachers. These observations and interviews provided additional information on the degree of active participation of the students in the research, their level of commitment and their perception of the impact of the project on their integral formation.

Based on the results of these evaluations, it was possible to determine the positive impact of the training project on the development of students' research skills. Significant improvements were observed in areas such as formulation of research questions, design of experiments and communication of results. These results supported the effectiveness of the project and its contribution to the academic and formative development of students in Natural Sciences.

Thus, the evaluation before and after the acquisition of research skills in the students made it possible to measure the impact of the training project and determine its effectiveness in the development of these skills. The results obtained supported the importance of involving students in real research and provided a solid basis for the implementation of similar strategies in the educational setting.

Discussion and Conclusions

Although formative research is fundamental for the integral formation of students, the focus on the development of research skills must be adapted to the pedagogical and contextual conditions of the country. Several authors have pointed out the importance of taking into account the available resources, both technical and human, as well as the needs and characteristics of the educational community.

For example, Núñez y Mora (2019) they point out that it is essential for teachers to be trained and updated in terms of teaching methodologies and technological tools that promote the development of research skills. In addition, Parra-Bernal et al. (2021) they emphasize the importance of considering students' interests and motivations when designing training projects, as this will guarantee their active participation and greater commitment to the research process.

On the other hand, it is necessary to bear in mind that the development of research skills implies overcoming cultural and social barriers that may limit access to sources of information and the exchange of knowledge. Authors such as Pérez (2020) emphasize the need to promote inclusion and equity in the formation of research skills, ensuring that all students have equal opportunities to participate in training projects.

Thus, the formative project for the development of research skills in high school students is an important strategy that allows students to develop their capacity for inquiry and critical thinking. However, it is necessary to adapt this proposal to the pedagogical and contextual conditions of the country, taking into account both the available resources and the needs and characteristics of the educational community. To this end, it is essential to have trained teachers, to consider the interests of students and to promote inclusion and equity in the training process. (Núñez y Mora, 2019perez, 2020; Parra-Bernal et al., 2021)

Using formative research strategies guarantees, to a large extent, positive effects on baccalaureate students in terms of the development of research skills. These skills are strengthened through training in observation, abstraction and synthesis, as students can link these skills to the analysis and interpretation of reality. According to Posligua y Ávila

(2022) it is necessary to propose new strategies within this approach with the objective of strengthening and/or developing methodological construction and teamwork skills in students.

As students master and engage in formative research skills, they deepen their acquisition of new knowledge, foster autonomous learning and the creation of more advanced and organized mental strategies. In addition, they develop critical and reflective thinking, cognitive independence, analytical and interpretive skills at a more advanced level.

The opinion of Oña (2019) agrees with the need to implement didactic strategies that allow for the development of school projects between teachers and students. To achieve this, it is essential to identify the main strategies according to the students' learning needs and the research process they are carrying out. These strategies should actively involve all participants, so that they generate results based on real situations and have a greater degree of significance and conceptual grounding in addressing real problems in the students' environment.

According to Álvarez et al. (2022)the development of formative projects in high school students is an effective strategy to promote research skills. This type of project, which integrates content from different areas of knowledge, allows students to mobilize their knowledge and seek solutions to society's problems. The results obtained in this study support the previous findings of the aforementioned authors, since it is evident that formative research has a positive impact on students.

In addition, it is important that the teachers who guide these projects have a solid research profile. According to Álvarez et al. (2022), teachers with research skills can more professionally guide the development of these skills in students. Therefore, it is necessary to provide ongoing training to teachers to enable them to successfully face this process of developing research skills in high school students.

Therefore, the present study supports the idea that formative projects are an effective strategy to promote research skills in high school students. These projects, structured in a collaborative manner and guided by professors with research skills, allow students to face current challenges and look for alternatives to solve society's problems. It is essential to promote ongoing teacher training to ensure adequate development of research skills in high school students, as suggested by Álvarez et al. (2022).

This need requires a transformation in the training models of educators, establishing a close link between teaching and research. According to Fernández et al. (2021)the convenience and possibility of early training for research. It has been shown that many research skills can begin to be developed as early as basic education, and successful programs have been mentioned that aim to facilitate the development of specific skills, such as those related to metacognitive reflection.

It has also been pointed out that it is not necessary to introduce new curricular spaces or topics in school programs to foster the development of research skills. The most important thing is to guide the learning experiences generated by teachers, the activities proposed in complementary materials such as textbooks, as well as to use appropriate work methods and promote participatory ways to involve students.

These findings are consistent with those found in this study, where the importance of the formative project for the development of research skills in high school students was evidenced. Through the training provided in this project, it was possible to observe how students acquired relevant skills to carry out effective research.

In summary, both Fernández et al. (2021) and our results support the idea that it is possible to train and promote research skills from early stages through appropriate

strategies implemented by educators. This coincidence further strengthens our training proposal and its potential positive impact on the educational environment.

The study reflects a lack of awareness on the part of teachers regarding the scenario and the importance of involving high school students in scientific research activities. This gap is still insufficient and needs to be addressed urgently. It is essential to strengthen the solution to current problems through research in different branches, especially in the Natural Sciences, since current studies in this field are insufficient to face current challenges.

The results of the study indicate that the preparation of teachers in scientific research should be a constant training task, in order to efficiently develop formative research in students.

The project presented, which addresses the problem of soil composition and the influence of nanoparticles in agriculture in the context of Natural Sciences, was evaluated by experts and stakeholders. The evaluation was remarkably pertinent, sufficient and feasible, both to solve the basic problem and to favor the development of the research skills of the high school students at the Alfonso Laso Bermeo Educational Unit in Quito, Ecuador.

Although there are several factors that affect the development of research skills in Ecuadorian high school students, in this study a project linked to Natural Sciences was implemented. The response from both teachers and students was favorable, which confirms the viability of the project to increase these skills. It also served as a guide for rethinking future actions in the planning and execution of training projects.

The results obtained provided adequately structured scientific information to diagnose the problems related to research skills in students. These findings also provide guidelines to propose a redesign of the curricula and a conscious introduction of these contents.

However, despite the positive assessment by experts and stakeholders, it is necessary to identify and execute specific activities by each project member or designated team within the established time frame and with the necessary resources. This must be aligned with the general objectives and activities defined for each research training area, whether specific subjects, extracurricular work or outdoor practices.

In summary, this study demonstrates that the training project implemented has been effective in developing research skills in Ecuadorian high school students. The results obtained support the importance and the continued need to promote this type of educational projects aimed at strengthening research from the early stages.

It should be noted that the development of research skills allows students to acquire the necessary competencies to perform in the scientific field, such as critical thinking, information search and analysis, and the ability to design and carry out experiments, among other aspects. Therefore, it is necessary to promote a formative approach that takes into account not only the natural sciences, but also the social sciences, since both fields can contribute to the development of research skills in high school students.

In relation to this, Martinez (2019) points out that the reductionist approach to teaching science in the natural sciences limits students' critical thinking and distances them from the possibility of understanding the complexity of social and scientific phenomena. Therefore, it is necessary to broaden the view and promote research training that allows students to develop research skills in both the natural and social sciences.

In accordance with the above, Fuentes et al. (2019) argues that research training at the baccalaureate level should focus on the development of skills such as observation, data recording, analysis of results, hypothesis generation and critical reflection. These

skills are not only relevant in the natural sciences, but also in the social sciences, as they allow students to understand and analyze complex phenomena.

In summary, it is essential to recognize the importance of promoting research training in high school students, with an approach that goes beyond the natural sciences and also includes aspects related to the social sciences. This will allow the development of research skills in students and will contribute to the development of a global and critical vision of science. It is therefore necessary to review current educational approaches and work on the construction of strategies that promote comprehensive training and prepare students and teachers to face the challenges of today's scientific world.

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