

Original article



## **Pedagogical strategy to contribute to the development of scientific culture in**

## **Pre-University Vocational Institutes of Exact Sciences**

**Estrategia pedagógica para contribuir al desarrollo de la cultura científica en los Institutos Preuniversitarios Vocacionales de Ciencias Exactas**

**Estratégia pedagógica para contribuir com o desenvolvimento da cultura científica em Institutos Vocacionais Pré-Universitários de Ciências Exatas**

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### **ABSTRACT**

The article presented is the result of the research project "Development of talent for the study of Exact and Natural Sciences of students of the Pre-University Vocational Institute of Exact Sciences that is developed at the University of Sancti Spíritus José Martí Pérez of Cuba." Its objective is to disseminate a strategy that contributes to the development of scientific culture among students at the Eusebio Olivera Rodríguez Pre-University Vocational Institute "Eusebio Olivera Rodríguez". The theoretical methods used were historical-logical, analytical-synthetic, inductive-deductive, documentary analysis, and systemic-structural-functional, to determine the state of research on scientific culture, develop the theoretical framework, and formulate the requirements to be

considered during the strategy's implementation; likewise, modeling and the systemic-structural-functional approach were used to develop the strategy. The fundamental results are the determination of the theoretical and methodological foundations of scientific culture and its development, and the strategy designed to contribute to the development of scientific culture among students at the aforementioned educational institution. The main conclusions of the work lie in the arguments that demonstrate the importance of developing scientific culture in individuals, institutions, and society; as well as the relationship between the terms "science education" and "scientific culture" and the role of education in its development, which are expressed in the design of the actions that make up the strategy.

**Keywords:** scientific culture; science education; strategy; teaching-learning process.

## RESUMEN

El artículo que se presenta es resultado del proyecto de investigación Desarrollo del talento, para el estudio de las Ciencias Exactas y Naturales, de los estudiantes del Instituto Preuniversitario Vocacional de Ciencias Exactas que se desarrolla en la Universidad de Sancti Spíritus José Martí Pérez de Cuba. Su objetivo es socializar una estrategia que contribuye al desarrollo de la cultura científica de los educandos del Instituto Preuniversitario Vocacional de Ciencias Exactas "Eusebio Olivera Rodríguez". Los métodos teóricos utilizados fueron el histórico-lógico, el analítico-sintético, el inductivo-deductivo, el análisis documental y el sistémico-estructural-funcional, para la determinación del estado de los estudios acerca de la cultura científica, la elaboración del marco teórico y formular las exigencias a tener en cuenta durante la implementación de la estrategia; de igual modo la modelación y el sistémico-estructural-funcional para la elaboración de la estrategia. Los resultados fundamentales son la determinación de los fundamentos teóricos y metodológicos acerca de la cultura científica y su desarrollo y la estrategia diseñada para contribuir al desarrollo de la cultura científica de los educandos de la mencionada institución educativa. Las principales conclusiones del trabajo radican en los argumentos que demuestran la importancia del desarrollo de la cultura científica en los individuos, las instituciones y la sociedad; así como la relación entre los términos "educación científica" y "cultura científica" y el rol de la educación en su desarrollo, los que se expresan en el diseño de las acciones que conforman la estrategia.

**Palabras clave:** cultura científica; educación científica; estrategia; proceso de enseñanza-aprendizaje.

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## RESUMO

Este artigo apresenta os resultados do projeto de pesquisa Desenvolvimento de talentos para o estudo das Ciências Exatas e Naturais em estudantes do Instituto Vocacional Pré-Universitário de Ciências Exatas, que está sendo realizado na Universidade José Martí Pérez de Sancti Spíritus, Cuba. Seu objetivo é disseminar uma estratégia que contribua para o desenvolvimento da cultura científica entre os estudantes do Instituto Vocacional Pré-Universitário de Ciências Exatas "Eusebio Olivera Rodríguez". Os métodos teóricos utilizados foram o histórico-lógico, o analítico-sintético, o indutivo-dedutivo, a análise documental e o sistêmico-estrutural-funcional. Esses métodos foram utilizados para determinar o estado atual da pesquisa sobre cultura científica, desenvolver o arcabouço teórico e formular os requisitos a serem considerados durante a implementação da estratégia. Da mesma forma, a modelagem e a abordagem sistêmico-estrutural-funcional foram utilizadas para desenvolver a própria estratégia. Os principais resultados são a determinação dos fundamentos teóricos e metodológicos da cultura científica e seu desenvolvimento, e a estratégia elaborada para contribuir com o desenvolvimento da cultura científica entre os estudantes da referida instituição de ensino. As principais conclusões deste trabalho residem nos argumentos que demonstram a importância do desenvolvimento da cultura científica em indivíduos, instituições e na sociedade; bem como na relação entre os termos "educação científica" e "cultura científica" e o papel da educação em seu desenvolvimento, aspectos que se refletem na concepção das ações que compõem a estratégia.

**Palavras-chave:** cultura científica; educação científica; estratégia; processo de ensino-aprendizagem.

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## INTRODUCTION

The United Nations (UN, 2018) considers the achievement of quality education as the basis for improving people's lives; and, precisely, one of the goals of its fourth objective points to the need for learners to acquire the knowledge necessary to promote sustainable development.

Hence the challenge of providing a well-rounded education for students, and to this end, the Third Improvement of the Cuban educational system is based on the principle that "the development of science is advancing by leaps and bounds, therefore education must incorporate scientific advances and the development of new technologies" (Navarro *et al.*, 2021, p. 9). Indeed, it recognizes scientific and technological education as a component of educational content and comprehensive training. For this reason, the development of scientific education and, consequently, of scientific culture, is an indispensable premise for achieving the aforementioned goals.

The analysis conducted confirms the importance of developing scientific culture. Among the reasons that demonstrate this are: its role in vocational training for the study of science, the existence of the Latin American Network of Scientific Culture and the Ibero-American Community of Educators for Scientific Culture, and the need to transform attitudes toward science in new generations.

Among the main researchers of scientific culture and education, identified by the authors of the article, are: Reid and Hodson (1993), Quintanilla (2010), Gómez (2012), Reyes (2012), Albornoz (2014), Piña and León (2014), Vilá (2017), Asencio (2017), Macedo (2016), Carmo (2020), Bestard and Ramos (2020), Martínez (2022) and Rodríguez (2025).

Asencio (2017) considers that "The essential idea on which scientific education is focused in the current era is to educate people in scientific-technical content, [...]" (p. 289) and also recognizes that the components of scientific education are: the cognitive, the procedural, the affective, the evaluative and the participatory.

According to Gómez (2012): "[...] the expression scientific culture began to be prolific in the early nineties in the Anglo-Saxon world and, at the end of the century, in the Ibero-American world, becoming established in the educational and public policy fields of science in less than a decade" (p. 28).

Currently, scientific culture includes knowledge about objects, phenomena and processes related to science and technology, achievements, interests, feelings, values, convictions and ways of acting that enable man to relate harmoniously with nature and society.

According to Macedo (2016), scientific culture should develop the creative spirit, individually and collectively, in subjects and, in turn, facilitate their active integration that allows them to build a better society.

According to Vilá (2017), scientific culture is a general attribute of the functioning of society and its development must be effectively and affectively promoted from education and from all citizen actions associated with science, technology and innovation.

According to Carmo (2020), a citizen's scientific culture is expressed in their basic knowledge to solve their essential needs of daily life, in being an active subject in society, and in their ability to enjoy the beauty of knowledge, even if they do not have to use it.

Bestard and Ramos (2020) consider that scientific culture and its development play an important role in the education of new generations by providing them with scientific knowledge, habits and values that translate into thinking tools, necessary to be able to transform society from responsible and creative attitudes.

According to Rodríguez (2025):

The notion of scientific culture privileges the socio-environmental character of scientific knowledge, it assumes the existence and possibility of access to a type of knowledge about science that results from the sum or interaction of valuable scientific knowledge and everyday-spontaneous knowledge provided by daily experiences and mediated by education [...] (p. 109).

The authors of this article adopt the viewpoint of Reyes (2006, cited by Reyes, 2012), because he relates culture to scientific education, when he states that scientific culture is:

The process and outcome of scientific education that includes knowledge about science and technology, the skills to achieve and use them, impacting the modes of citizen action in the different contexts that confirm the degree of humanization achieved by man, in correspondence with the interests and needs of the society in which he lives (p. 24).

Scientific culture integrates knowledge and skills related to the development of science, as well as attitudes and values that express the link between man and science in a specific context.

Reyes (2012) states that the development of scientific culture results from a gradual, conscious and individual formation process and, in addition, acquires new elements as the development of science and technology advances.

This confirms two other essential elements for the development of scientific culture: it is an intentional and planned process and, in turn, requires the subjects' active and conscious participation.

On this point, Reyes (2012) specifies that, in the educational context, it is necessary to transmit the historical and social experience of knowledge of science and technology, experimentation, and the development of skills for the use of information, writing, the expression of ideas, and the argumentation of what has been observed; all of which contributes to the scientific conception of the world.

There are shared as recommendations to consider for the development of scientific culture. The following stand out among them:

- "Update the school curriculum, based on the development of the particular sciences and the social and ethical implications of scientific-technical development in them" (p. 291).
- "To introduce into the curricular conception of the disciplines a vision that reflects science as a process in continuous construction and evolution, committed to ethical values and interests of society and conditioned by the context" (p. 291).
- "Integrate social, cultural, ecological, and economic concerns, according to the potential of the content; to achieve a comprehensive perception of the world, its complexity, and the interactions between global and local problems, their causes, and possible solutions" (p. 292).
- "To generate responsible and supportive attitudes and behaviors, in order to achieve individual changes in lifestyles and customs that promote the rational and efficient use of resources and awareness" (p. 292).
- "To promote a learning culture that allows the use of methods that energize the learning process and enhance cognitive development, thinking, intelligence, motivation and interest in studying" (p. 292).
- "To promote, from the teaching-learning process (TLP), the use of procedures of scientific activity that promote reflection, interpretation, modeling, hypothesis formulation and the search for information from different sources" (p. 292).

- "To perfect problem-solving in the teaching-learning process, incorporating situations of theoretical and experimental interest and open or closed problems during independent work" (p. 292).
- "Incorporate experimental work into the subjects that correspond to it, as a basic component of the teaching-learning process, promoting the solution of tasks that require experimental design" (p. 292).
- "To develop materials to support learning, in printed, audiovisual and computer formats, with updated approaches in scientific and pedagogical content" (p. 292).
- "Renew the concept of evaluation, so that autonomous and self-regulated learning is fostered, so that the student builds his or her own knowledge (...), which allows him or her to learn throughout life" (p. 292).
- "To promote a scientific education that adapts to the needs and personal characteristics of the students, taking into account the diverse social and cultural contexts of origin" (p. 292).

These ideas also achieve an integrated analysis of scientific culture and emphasize its development from the teaching-learning process; managing to make a journey through all its components.

From what has been stated above, the relevance and currentness of the theoretical study of the topic associated with the development of scientific culture from the pedagogical context and analyzed as an integral part of general culture (Macedo, 2016), as a way to educate citizens from and by all citizens (Vilá, 2017) and as a necessary tool for the transformation of society (Bestard & Ramos, 2020) is corroborated.

Given that the main result presented in this article is a pedagogical strategy, it is important to clarify that:

Strategy is a specific ordering of actions in the course of solving a problem, in which each step is necessary for the next. These sequences of actions are strongly oriented toward the goal to be achieved. Persistence in a procedure or its modification is also related to the success achieved in reaching a goal (Rodríguez & Rodríguez, 2011, p. 34).

Furthermore, the pedagogical strategy is considered to be "The projection of the pedagogical direction that allows the transformation of a system, subsystem, institution or educational level to

achieve the proposed goal and that conditions the establishment of actions to obtain changes in the dimensions that are involved in obtaining that goal" (Rodríguez & Rodríguez, 2011, p. 38).

The objective of this article is to socialize a pedagogical strategy that contributes to the development of the scientific culture of the students of the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences in the province of Sancti Spíritus.

## **MATERIALS AND METHODS**

The study was based on the dialectical-materialist conception and required the use of a quantitative methodology during the research process.

Theoretical methods were used to design the pedagogical strategy, including the historical-logical, analytical-synthetic, inductive-deductive, and systemic-structural-functional methods, which allowed the determination of the foundations assumed in relation to scientific culture and its development; as well as the theoretical positions that support the design of the strategy as a type of scientific result and its structure.

For the literature review related to the development of scientific literacy, a set of scientific articles on the topic published in specialized journals was studied. The following keywords were used in the information search: science education, scientific literacy, and scientific competence. Articles were selected based on their publication in journals indexed in databases as Scopus, Scielo, Redalyc and Latindex, among others; that corresponded to national and foreign authors and that had been published after the year 2010, except for exceptions that due to their contribution and validity of the ideas presented should not be excluded.

The documentary analysis method was applied to several normative documents: the study plan of Pre-University Education and the programs of the disciplines Biology, Chemistry, Mathematics, Informatics and Physics of the aforementioned educational level, with the purpose of identifying the level of requirements and methodological recommendations associated with the development of scientific culture.

Several scientific articles were also studied, with the purpose of identifying the main trends in the formation and development of the students' scientific culture and being able to formulate requirements to be taken into account in the implementation of the strategy.

Modeling and the systemic-structural-functional method were used in the strategy development process.

## RESULTS

### **Foundations of the pedagogical strategy to contribute to the development of scientific culture**

Among the main theoretical aspects that have been taken into account for the development of the pedagogical strategy are those presented at the end of the introduction of this article.

The term "scientific culture" began to be used in the 1970s in countries such as France, Canada, and England, later spreading to English-speaking countries and, by the end of the century, to Latin American countries. In its early stages, scientific culture had a cognitive focus.

Scientific literacy is necessary to control risks, use results responsibly, and promote innovation; this requires information and the encouragement of its development in students from early childhood.

Scientific culture is assumed to include knowledge about concepts, phenomena, processes, laws and the development of skills related to science and technology, interests, feelings, values, convictions and ways of acting that enable man to relate harmoniously with nature and society.

It is recognized that the development of scientific culture must be oriented towards recognizing science, technology and innovation as a fundamental path for the transformation of society and that the school must guarantee the training and development of the culture of all students.

Scientific culture integrates knowledge and skills related to the development of science; as well as attitudes and values that express the link of man with science in a specific context.

In contemporary scientific culture, a humanistic approach is emerging as an essential element influencing the development of humankind, science, and society itself, as well as its systematic

transformations. Likewise, the role of education in this development is recognized, particularly its relationship with science education.

Scientific culture is understood from an integrative theoretical perspective, characterized by a social, humanistic, and transformative approach that analyzes it as the result of the scientific education acquired by individuals within the educational context and the socio-community environment. Furthermore, it is understood that scientific culture comprises two dimensions: an individual one and a social one; and that it can refer to individuals, institutions, and societies.

In order for educational institutions to foster the development of scientific culture, the pedagogical process must promote:

- the formation and establishment of concepts.
- the development of problem-solving skills.
- the development of experimental skills.
- the application of scientific knowledge in different situations.
- the use of technology for different purposes.
- Knowledge of the history of science and its implications for the development of society.
- the knowledge and application of the scientific method in a systematic way.
- the holding of competitions, olympiads and excursions.
- visits to production and research centers.
- The exchange with personalities from science, culture, etc.
- Participation in scientific societies and research groups.

All of the above should be done using methods that favor the expression of ideas, argumentation, the use of information and communication technologies, and participation in solving problems of the community and the context where the student develops.

### **Pedagogical strategy to promote the development of scientific culture**

The strategy is structured as follows: general objective and stages (diagnosis, planning, execution and evaluation) which in turn contain objectives, actions, methodological guidelines and forms of implementation.

The strategy presented is characterized by: the integration of teaching-learning activities with other extracurricular activities, its systemic nature, and by promoting the active participation of the entire educational community, in order to develop the scientific education of the students.

For the pedagogical strategy to contribute to the development of students' scientific culture, it is recommended that the following requirements be taken into account:

- Prioritize, in the educational project of the school institution, the development of the scientific culture of all students.
- The active participation of all teachers of exact and natural sciences in the direction of the pedagogical process.
- To promote the development of talent for the study of exact and natural sciences.
- To promote interest in the study of exact and natural sciences.
- To encourage the active participation of students in all planned activities.
- Identify the potential of the community and the family in relation to the development of scientific culture.

The strategy is designed to be used by the directors of the educational institution (director, deputy directors and coordinators of cultural areas) and by the teachers and other educators during the direction of a pedagogical process that favors the formation of the scientific culture of the students.

The overall objective of the strategy is to perfect the process of forming a scientific culture in the students of the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences.

The design of the strategy involves setting specific objectives, actions, and methodological guidelines for each stage.

### **Diagnostic stage**

Objective: To diagnose the level of development of the scientific culture of the students of the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences.

## Actions

- Determination of the dimensions and indicators to be evaluated in the diagnostic process.
- Selection of methods and design of instruments to be used for the development of the diagnosis.
- Application of the instruments to be used for carrying out the diagnosis.
- Information processing and evaluation of results at different management levels of the Pre-University Vocational Institute of Exact Sciences and projection of corrective actions to eradicate the identified weaknesses.

## Methodological guidelines for its implementation

The authors of this article propose using the following variables in the diagnosis:

Variable 1: level of requirements and methodological recommendations of the guiding documents associated with the development of scientific culture.

Variable 2: level of contribution of the pedagogical process to the development of the scientific culture of the students.

Variable 3: level of development of the scientific culture of the students.

The fundamental methods to be used for carrying out the diagnosis are: observation, survey and document review.

It is recommended to review the main normative and methodological documents, observe school murals and classes to assess their contribution to the development of the scientific culture of students, survey teachers of the exact and natural science subjects to obtain information about the level of development of the scientific culture of students and interview directors, teachers and students to evaluate the contribution of audiovisuals; visits to centers of economic and scientific interest; conferences and talks with personalities; participation in scientific societies and events and participation in the solution of local or territorial problems to the development of the scientific culture.

For processing the information, frequency tables and other descriptive statistical resources should be used to identify the strengths and weaknesses in the development of the scientific culture of the students.

## Planning

Objective: To design actions to promote the development of scientific culture among students at the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences.

The actions in this stage are part of long-, medium-, and short-term planning and its outcomes. According to the authors of this article, they should be documented in methodological analyses, lesson plans, or the school's educational project, as appropriate.

### Actions

- Planning classes in a way that takes advantage of the potential of the content for: the formation and consolidation of concepts; the development of the ability to solve problems; the development of experimental skills; knowledge of the history of science; the development of the evaluative component and the knowledge and application of the scientific method.
- Design of school murals, radio programs, mobile phone applications and other forms of dissemination of the results of science and the life and work of the most recognized scientists in the areas of exact and natural sciences.
- Design of a program of visits to research centers, industries, museums and other institutions in the territory that have potential to promote the development of scientific culture.
- Development of a program of conferences and discussions with personalities from science and culture in the province and the country.
- Design of a program for the screening and discussion of audiovisual materials, whose content offers potential to promote the development of scientific culture and preparation of guides for the observation of audiovisual materials.
- Design of the work of student scientific societies and of the participation of students in scientific events.
- Designing the participation of students in solving local or territorial problems.

## **Methodological guidelines for its implementation**

To promote knowledge of the history of exact and natural sciences in the classroom, one can work in two main directions: the study of the life and work of scientists, linking it with the content under study, and the study of the life and work of prominent figures in science or in teaching in subjects within the area of exact and natural sciences, relating it to international, national or local events.

It is recommended that in each subject, scientists whose life and work can be studied be identified, linking it to the content under study, and those personalities whose life and work can be studied, in correspondence with the anniversaries.

For example, in the teaching and learning process of mathematics, one can study the life and work of the British mathematician of French origin, Abraham de Moivre, when studying the theorem that bears his name for calculating powers with natural exponents of complex numbers represented in trigonometric form. The same occurs with Carl Friedrich Gauss when studying the fundamental theorem of algebra.

You can also study the life and work of outstanding Cuban professors such as Luis J. Davidson on the day of his birth (September 10, 1921) or his death (November 10, 2011), or on the anniversary of the founding of the Honorary Chair that bears his name at the University of Sancti Spiritus José Martí Pérez (March 24, 2016).

Although there are specific experiences of visits to research centers, industries, museums and other institutions in the territory that have potential to promote the development of scientific culture, it is advisable to develop a visit plan for each grade in the school year, taking into account the needs that arise from the teaching-learning process of the subjects and the potential of the centers in the territory.

The process for developing the program of lectures and discussions with leading figures in science and culture in the province can be similar to that described above, but with consideration for the potential of local specialists. Opportunities to invite specialists from other regions should not be overlooked when feasible, even if not included in the initial plan.

In the process of developing the program for the screening and discussion of audiovisual materials, it is advisable that specialists (teachers, art instructors, members of the local Writers and Artists Union, local researchers, and others) submit a proposal for the school year for each grade level. This proposal must be approved by the school's governing board.

The use of computer resources and, in particular, artificial intelligence constitutes a cross-cutting axis for all those actions where it is feasible.

### **Execution**

Objective: to execute the actions designed with the purpose of promoting the development of the scientific culture of the students of the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences.

#### Actions for teachers

- Teaching classes as planned, in such a way as to take advantage of the potential of the content for: the formation and consolidation of concepts; the development of the ability to solve problems; the development of experimental skills; knowledge of the history of science; the development of the evaluative component and the knowledge and application of the scientific method, according to the potential of the content and the typology of the class.
- Advising students, arts instructors, and computer specialists on the creation of school murals, radio programs, mobile phone applications, and other forms of disseminating the results of science and the life and work of the most recognized scientists in the areas of exact and natural sciences.
- Direction of visits to research centers, industries, museums and other institutions in the territory that have potential to promote the development of scientific culture.
- Preparing students to actively participate in conferences and discussions with personalities from science and culture in the province and the country.
- Direction of the audiovisual debate, which content offers potential to promote the development of scientific culture.
- Advising students who are parts of student scientific groups.
- Management of social, cultural, technical or productive projects, promoting the participation of students in solving local or territorial problems.

#### Actions for students

- Active participation in the classes of exact and natural sciences; in audiovisual debates; in conferences and conversations with personalities; in visits to research centers, industries, museums and other institutions of the territory; in scientific societies and in projects.
- Completion of the learning tasks guided by the teachers in each of the classes of the natural and exact science subjects.
- Collaboration in the creation of school murals, radio programs and other forms of dissemination of the results of science and the life and work of the most recognized scientists in the areas of exact and natural sciences.

#### **Methodological guidelines for the implementation of teachers' actions**

It is recommended that student participation be encouraged during class, in accordance with the predominant didactic function. For example, in a class where the predominant didactic function *is the presentation of new content* and a concept is being formed inductively, teachers should encourage student activity during the main actions to be carried out, which are: establishing the starting point, motivating students, guiding them toward the objective, separating common and uncommon characteristics, and defining the concept.

If it is a class where the predominant didactic function is reinforcement through problem solving, it is important that problems of different degrees of difficulty are solved, that the fundamental phases of the problem-solving process are taken into account (orientation towards the problem, working on the problem, solving the problem and evaluating the solution and the path), as well as the fundamental tasks of each stage and that the independent work of the students is encouraged.

Laboratory practices constitute a powerful tool, not only for learning, but also for providing the possibility of understanding how knowledge is built within the scientific community and allows for a better understanding of the topics covered in class, through hypotheses and questions that can be confronted in practice.

To contribute to the understanding and application of the scientific method, teachers of all subjects should work to ensure that students make observations, which is perhaps the most important phase of all, since it is through observation that they obtain the necessary data to work with in subsequent

phases. These observations will allow them to define problems, formulate hypotheses, experiment, analyze data, and arrive at conclusions that they can communicate effectively. Similarly, scientific societies should prioritize working with the scientific method, thereby fostering the development of research skills and motivation for the study of science and, at the same time, for doing science in students.

It is advisable that teaching groups develop a proposal of historical events, linked to each subject, to use in classes and in the creation of school murals, radio programs and other forms of dissemination.

For the use of the history of exact and natural sciences, it is recommended to guide in advance one or two selected students to search for the information, prepare a biographical summary that they must read and comment on during the class on the previously established day; the rest of the students can ask questions and expand the information if they wish.

For visits to research centers, industries, museums, and other institutions in the region that have the potential to foster the development of scientific culture, it is advisable to provide prior guidance. This guidance may include suggesting the use of bibliographic resources and preparing an observation guide.

Students should be encouraged, individually or in small groups, to prepare a report of the visit and discuss it within the group.

In preparing students to participate in conferences and discussions with figures from science and culture, it is advisable to inform them beforehand about the topic to be discussed so that they can research it and prepare possible questions for the exchange with the speaker.

### **Methodological guidelines for the implementation of learners' actions**

During the activities assigned to students, they must develop their skills for independent work and achieve active participation in the different activities of the teaching-learning process and extracurricular activities.

In this regard, it is recommended that students prepare beforehand using the guidance provided by their teachers. Consulting various bibliographic sources is essential for carrying out the proposed activities. Preparation can sometimes be done in pairs or small groups.

## **Assessment**

Objective: To evaluate the quality with which the actions of the strategy are carried out and their effectiveness in promoting the scientific culture of the students of the Eusebio Olivera Rodríguez Pre-University Vocational Institute of Exact Sciences.

Evaluation is a process, so at each stage, the results obtained must be assessed and the necessary adjustments made. However, at this stage, actions should be taken to evaluate the results achieved through the implementation of the strategy.

### **Actions**

- Self-assessment of the process followed during the stages of diagnosis, planning and execution.
- Conducting analysis and evaluation sessions of the strategy implementation process and the results obtained at each stage among the members of the educational institution's management.
- Observation of the performance of teachers and students and assessment of the identified regularities.
- Design of new actions or redesign of the actions conceived, according to the results obtained in the stages of diagnosis, planning and execution of the strategy.

## **Methodological guidelines for its implementation**

The first action must be carried out during the development of each of the stages mentioned, as it contributes to introducing improvements before the execution stage of the strategy that contribute to obtaining superior results in the formation of the scientific culture of the students.

The second action must be carried out at all stages of the strategy and must favor collegial decision-making and the commitment of managers to the implementation and results of the strategy.

The third is very important, as it allows for the systematic evaluation of the performance of teachers in the execution of each of the actions corresponding to the first three stages of the strategy and of the students in the third of them.

To evaluate the results, it is recommended to focus on two aspects: the quality of the actions carried out and the level of scientific literacy developed by the students. The process should conclude with an assessment of the strengths and weaknesses of the approach to developing scientific literacy among the students at the educational institution.

Once the process of identifying strengths and weaknesses is complete, the strategy should be redesigned and a new cycle of its application should begin.

## **DISCUSSION**

The bibliography consulted during the research and preparation process of this article contains answers to questions such as: what is scientific culture? (Quintanilla, 2010; Reyes, 2012; Vilá, 2017; Rodríguez, 2025); What are the components of scientific culture? (Asencio, 2017; Piña & León, 2014; Rodríguez, 2025); How has the concept of scientific culture evolved? (Gómez, 2012); What is science education? (Asencio, 2017); What are the components of science education? (Asencio, 2017); What is the relationship between science education and scientific culture? (Reyes, 2012); why is it important to develop scientific culture? (Bestard & Ramos, 2020; Martínez, 2022).

The theoretical study carried out reaffirms the importance of the development of scientific culture in individuals, institutions and society; the relationship between scientific education and scientific culture and the role of education in its development.

It also reveals a social, humanistic, and transformative approach that understands scientific culture as the fundamental outcome of science education, acquired through the pedagogical process, the media, and the actions of communities with the potential to foster it. Furthermore, it demands mastery of knowledge, the development of skills, and the attitudes characteristic of science and the work of scientists. These theoretical positions have proven essential for designing the pedagogical strategy.

There are few or no bibliographic sources that answer the question: how to determine the state of development of scientific culture in students of an educational institution or a group of students?

In trying to answer the question "what to do to develop scientific culture in students?", very valuable ideas were obtained (Reid & Hodson, 1993; Asencio, 2017) that were used in the development of the strategy, but these are not conceived as a system, nor is it specified how teachers and other educators in educational institutions should proceed to achieve it.

The strategy proposed by the authors of this article answers the last two questions formulated in the previous paragraphs in the context of the IPVCE Eusebio Olivera Rodríguez, based on the theoretical foundations presented, the experience and creativity of the authors and the results of the diagnosis carried out before its preparation.

The strategy includes actions not considered by other authors, among them: the use of school murals, radio programs, mobile phone applications and other media for the dissemination of the results of science and the life and work of the most recognized scientists in the areas of exact and natural sciences; and the projection and discussion of audiovisuals, whose content offers potential to develop the scientific culture of the students.

It also includes methodological guidelines for each stage (diagnosis, planning, implementation, and evaluation). For implementation, it outlines actions and guidelines for both teachers and students that can facilitate the strategy's implementation and address the limitations mentioned at the beginning of this section.

Implementing the strategy faces challenges, including ensuring adequate staffing levels (teachers and administrators), clearly defining the actions within the institution's educational project, specifying dates and responsible parties, securing the involvement of all teaching staff, and guaranteeing the availability of essential material resources. Its effectiveness can be partially assessed at the end of each academic year, with more comprehensive evaluation criteria available at the end of each cohort.

To expand and specify the methodological guidelines, some complementary materials have been prepared by the researchers and collaborators of the research project that can contribute to the preparation of teachers.

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### **Conflict of interest**

Authors declare no conflict of interests.

### **Authors' contribution**

The authors participated in the design and writing of the article, in the search and analysis of the information contained in the consulted bibliography.



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