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El tratamiento a la cultura científica en la enseñanza-aprendizaje de la Biología Molecular y Celular
The treatment to the scientific culture in the teaching-apprenticeship of the Molecular and Cellular Biology

Yailin Casamayor-Alcantara; Giolvys Basulto-González

Universidad de Guantánamo, Guantánamo, Cuba
Correo (s) electrónico (s)
yailin@cug.co.cu
giolvysbg@cug.co.cu
ORCID: https://orcid.org/ 0000-0002-1359-1706
https://orcid.org/0000-0003-3099-1661

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Resumen

El tratamiento a la cultura científica en el proceso de enseñanza-aprendizaje, permite al estudiante percibir la aplicabilidad e impacto social de los resultados de la ciencia, la tecnología y la innovación asociados a los contenidos de enseñanza, un problema aún no resuelto. De ahí, que el objetivo del presente trabajo es proponer una estrategia didáctica para el tratamiento a la cultura científica en el proceso de enseñanza-aprendizaje de la disciplina Biología Molecular y Celular de la carrera Licenciatura en Educación Biología. Los métodos de investigación aplicados posibilitaron identificar insuficiencias en relación con la aplicación y valoración del impacto social de estos contenidos. La aplicación de la estrategia contribuyó a la preparación didáctica y metodológica de los docentes en la solución de las situaciones profesionales en la escuela media relacionadas con la manera de enseñar y aprender estos contenidos, teniendo en cuenta el desarrollo actual de las ciencias biológicas.

Palabras clave: Proceso de enseñanza-aprendizaje; Biología Molecular y Celular; Cultura científica; Estrategia didáctica.

Abstract

The treatment of scientific literacy in the teaching-learning allows students to perceive the applicability and social impact of the results of science, technology, and innovation associated with the teaching content, a problem that remains unsolved. Therefore, the objective of the work is to propose a didactic strategy for the treatment of scientific culture in the teaching-learning process of the Molecular and Cellular Biology discipline in the Bachelor's Degree in Biology Education. The applied research methods made it possible to identify deficiencies in relation to the application, and assess the social impact of these contents. The application of the strategy contributed to the didactic and methodological preparation of teachers in solving professional situations in middle school related to the way of teaching and learning these contents, taking into account the current development of the biological sciences.

Keywords: Teaching-learning process; Molecular and Cellular Biology; Scientific culture, Didactic strategy.

Introduction

The 21st century is characterized by a sociocultural revolution, based on the rapid development of science and the social impact of its practical applications. In the educational context, based on the requirements of the 2030 Agenda for Sustainable Development (UN, 2015), related to quality education and the contribution to sustainable development, it is necessary that ***In the teaching-learning process,*** the impacts and biotechnological applications of biological sciences are revealed when solving everyday problems in a responsible and critical way, this allows overcome traditionalism and decontextualization, so as to promote education for life.

The above is evident in the third stage of the Continuous Improvement of the National Education System, in which new educational approaches and components are introduced, in order to To achieve the comprehensive training of a competent and creative professional with a mastery of science and technology, so as to achieve proper didactic and methodological preparation that allows them to face new educational challenges.

In this regard, the model of the professional of the Bachelor's Degree in Biology Education, in the E Study Plan (Ministry of Higher Education [MES], 2016), makes explicit in one of its professional problems, the need to contribute to scientific culture.

Molecular and Cellular Biology is present in this document. (Ministry of Higher Education, 2021) , a basic discipline whose interdisciplinary nature allows to consolidate and deepen the approach to the basic contents of the Biology discipline in the degrees of the basic secondary and upper secondary levels, as

well as to include a significant number of the main biotechnological impacts and applications of the biological sciences of the late 20th and early 21st centuries. This discipline thus acquires greater social significance, considering the role of its teaching-learning process in consolidating the formation of the scientific conception of the world, the assessment of the country's socioeconomic development and, therefore, the link between its contents and everyday life.

However, although the program objectives for this discipline explicitly state the need for scientific literacy, this is outlined in concrete examples and specific content. These generally lack didactic support, so their treatment is left to the empirical and spontaneous discretion of the teacher. Such treatment constitutes one of the requirements of Curriculum E for the Bachelor's Degree in Biology Education. Although it has been the subject of previous research, it requires innovations based on the scientific foundations inherent to this discipline.

The treatment of scientific culture in the teaching-learning process of science has been recognized nationally and internationally. The theoretical systematization carried out highlights the research of authors such as: Pérez *et al.* (2019); Montejo (2019); Ojeda (2019); Hernández & Hernández (2024); among others. Their conceptions reflect the need to respond to everyday life situations with the use of knowledge of science and technology. All of this allows us to overcome the formalism, the traditional approach and the decontextualization that have characterized the teaching-learning process.

In the context of the Molecular and Cellular Biology discipline, scientific literacy has innovative and transformative implications, enabling students to understand the implications of the development of the biological sciences and the impact of their biotechnological applications on everyday life. It also includes the development of skills, feelings, and modes of action that enable students to sustain reflective and critical judgment regarding science and technolog . This fosters an education for life that contributes to the local environment.

However, this conception of scientific culture has been insufficiently addressed in the teaching-learning process of this discipline, where a behaviorist stance still predominates, a memoristic, uncritical and unreflective conception, which limits the understanding, explanation, application and assessment of the social impact of biotic phenomena and processes at the molecular and cellular level, leading to the content lacking meaning for the student.

The research conducted within the Bachelor of Science in Biology Education program at the University of Guantánamo falls within these scientific perspectives. It addresses the shortcomings in the teaching-learning process of Molecular and Cellular Biology, which limit the coverage of scientific literacy, as a problem. Among the underlying causes is limited teacher preparation for the treatment of scientific

literacy in the Molecular and Cellular Biology program, which lacks a didactic foundation to guide its implementation in this educational context. Therefore, the proposed objective is to develop a didactic strategy for the treatment of scientific literacy in the teaching-learning process of Biology in the Bachelor of Science in Biology Education program.

Development

From the strengths and weaknesses identified in the diagnosis of the initial state of treatment to the scientific culture in the context of the discipline of Molecular and Cellular Biology in the Bachelor's Degree in Education A teaching strategy was developed for Biology. Within scientific research, the strategy is considered a contribution of research and can be classified as a result of practical significance, since its essential purpose is to project the process of transformation of the object of study from a real state to a desired state.

From a philosophical point of view, the proposed strategy is based on materialist dialectics, which offers an understanding of the world as a whole in constant change and transformation. Man transforms the environment to the extent that he transforms himself.

From a sociological perspective, it is based on the approaches of Narváez & Oyola (2015) regarding the link between the social environment and learning, which enables the development of critical thinking and a social awareness that allows students to evaluate the ethical and social impacts of scientific advances.

Psychologically, it is based on the recognition of the role of emotions in learning (Santoyo *et al* ., 2024), which enhances the teaching-learning process by integrating emotional and ethical elements, all of which leads students not only to learn the content of this discipline but also to appreciate its relevance in their daily and professional lives.

From a pedagogical perspective, the strategy is based on the postulates of critical pedagogy, applied to the development of a reflective and ethical stance in students facing scientific and social dilemmas that promote active participation and critical thinking (López*,* 2019 & Ríos de Cubilla, 2024).

The teaching strategy manifests itself as a system of short-, medium-, and long-term actions; its essential qualities are an expression of the result, at a practical level, of the dialectical interactions between the model's components of the same nature (Rodríguez *et al* ., 2020).

The strategy reveals its didactic nature, as it responds to the need expressed in the context of the teaching-learning process, by conceiving a path to address scientific culture in the discipline of Molecular and Cellular Biology , which promotes the application and appreciation of advances in the biological sciences and the impact of biotechnological applications on daily life.

Meanwhile, the objective of the teaching strategy is declared: to promote the treatment of scientific culture in the discipline of Molecular and Cellular Biology , based on the system of actions for the solution to the deficiencies presented, so that the performance of teachers for these purposes is encouraged.

The proposed strategy has the following attributes:

- Systemic: the levels of structural and functional relationship between the different stages and actions for the fulfillment of the proposed objective are interrelated and interact.
- Flexible: It is revealed in the possibility of adapting the stages, actions and forms of implementation during treatment to scientific culture.
- Contextualizable: it adjusts to the social demands of Higher Education, responds to the particular conditions of the Professional Model of the Graduate in Biology Education and to Biology teachers, in accordance with the diagnosed needs.
- Transformative: from its very essence, it is conceived to promote the treatment of scientific culture in the discipline of Molecular and Cellular Biology, which is reflected in responsible modes of action by the Biology teacher.

Its structure is dynamic with a systemic approach, and its development used the method of transition from the abstract to the concrete, which allowed its stages and actions to be sequenced towards the orientation of the procedure for addressing scientific culture in the teaching-learning process of the Molecular and Cellular Biology discipline.

It is conceived as a system guided by a general objective, stages with their respective objectives and actions, where hierarchical relationships are established between them. The stages are as follows:

- Diagnosis of the treatment of scientific culture in the teaching-learning process of the discipline of Molecular and Cellular Biology.
- Planning, organization and training for the treatment of scientific culture in the discipline of Molecular and Cellular Biology
- Implementation of actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology
- Evaluation of actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology

The stages that structure the teaching strategy are specified below:

Stage I. Diagnosis of the treatment of scientific culture in the teaching-learning process of the discipline of Molecular and Cellular Biology.

The objective of this stage is to determine the needs, weaknesses and potentialities that are recognized in the diagnosis, which is materialized in the following actions:

Action 1. Development and application of techniques and instruments for exploring the current state of teachers' preparation level with a view to addressing scientific culture in the discipline of Molecular and Cellular Biology.

An atmosphere of trust is fostered during interviews and group discussions. Indicators, techniques, and instruments to be considered for data collection and acquisition are determined. These indicators are included in the academic reports for the Molecular and Cellular Biology discipline. The indicators to be considered are:

- Mastery of the theoretical cores of knowledge related to scientific culture.
- Mastery of the educational potential of the content of the discipline.
- Mastery of the biotechnological impacts and applications of the biological sciences and their contextualization in the contents of the Molecular and Cellular Biology discipline.

Executes: researcher

Action 2. Processing of results and identification of needs, weaknesses and potentialities .

The results of the diagnosis allow for the identification of the needs, weaknesses, and potential of Molecular and Cellular Biology teachers in addressing scientific literacy. These results become the starting point for the search for a solution to the existing deficiencies in cognitive, procedural, and attitudinal aspects; thus, in the subsequent stages of the strategy, they constitute key moments in resolving the problem.

Executes: researcher

Stage 2. Planning actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology

The objective of this stage is to plan, based on the results of the diagnosis, the methodological work actions for addressing scientific culture in the discipline of Molecular and Cellular Biology.

The actions to be developed in this stage are directed at:

Action 1. Raising awareness among teachers in the didactic-methodological preparation actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology.

To this end, an exchange was promoted with the teachers of the Molecular and Cellular Biology discipline and the head of the multidisciplinary Biology group, in order to:

- Analyze the results of the diagnosis.
- Reflect collectively on weaknesses and strengths.

- Define the preparation needs of teachers in the discipline.
- Persuade them collectively of the need to implement the teaching strategy.

Executed by: researchers and teachers of the Molecular and Cellular Biology discipline

Action 2. Plan the preparation of teachers for the treatment of scientific culture in the discipline of Molecular and Cellular Biology.

Plan methodological work actions.

Considering the objectives of this research, methodological workshops are planned to discuss scientific culture and its implementation in the teaching and learning process of Molecular and Cellular Biology. In these workshops, professors will present experiences related to the topic under discussion. This allows for the development of alternative solutions to this problem based on the knowledge and experience of the participants.

In this regard, the following methodological workshops may be planned on topics related to:

- Active methodologies for the treatment of scientific culture in the discipline of Molecular and Cellular Biology .
- Impact of the biological sciences and their biotechnological applications. Their contextualization in the content of the Molecular and Cellular Biology discipline .
- Use of digital technologies in teaching Molecular and Cellular Biology.

Executed by: researchers and teachers of the Molecular and Cellular Biology discipline

Action 3. Establishment of a material and technical basis for the treatment of scientific culture, which includes:

- Preparation of a digital portfolio, containing a list of freely accessible online sites, as well as interactive platforms, specialized bibliographic sources, and audiovisual resources in different formats, which are of interest for the self-management of information related to the link between the contents of the Molecular and Cellular Biology discipline with current scientific and ethical issues, on the impacts of the biological sciences and their biotechnological applications in various areas of social development at the global, national, and local levels.

  These include interviews with relevant figures in the biological sciences of Guantanamo, scientific results from research centers in the region, and those associated with strategic sectors and research, development, and innovation projects that address the impacts and applications of the biological sciences.

Executed by: researchers and teachers of the Molecular and Cellular Biology discipline

Stage 3. Execution of actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology

Objective: To carry out the actions designed in the planning of the teaching strategy for the treatment of scientific culture in the discipline of Molecular and Cellular Biology.

The actions to be developed in this stage are:

Action 1. Develop the methodological workshops planned for the treatment of scientific culture in the discipline of Molecular and Cellular Biology.

In the methodological workshops, as part of teacher-methodological preparation, the experiences of teachers who have taught or are teaching Molecular and Cellular Biology will be discussed in relation to the approach to scientific literacy in this discipline. Critical reflection will be encouraged through debates and projects, and the connection between theoretical content and its practical application will be prioritized.

Performed by: researchers and teachers of the Molecular and Cellular Biology discipline.

Stage 4. Evaluation of actions for the treatment of scientific culture in the discipline of Molecular and Cellular Biology.

It constitutes an analysis of the level of impact and effectiveness on teachers, thereby contributing to feedback. Although it constitutes a closing phase, the systematic and ongoing process of monitoring and evaluation is present throughout the strategy's design and implementation from the first stage. This phase aims to assess the feasibility of the proposed actions.

This stage was conceived in two moments:

First stage The developed strategy was submitted for consideration by a group of specialists, who were selected based on: teaching status, scientific status, teaching experience, prior research experience, scientific publications, and participation in national and international events.

The following elements were taken into account for the validation of the strategy:

- Feasibility of implementation
- Current events and scientific rigor
- Adaptation to the recipients
- General evaluation

The group of experts consisted of one doctor of science, five master's degrees in science, and two graduates in biology education.

Second moment During the development of the strategic actions, which allowed for the necessary corrections and adjustments to be made according to the results of the evaluation of each of them in order

to continue working on their continuous improvement, since the treatment of scientific culture is a complex, contradictory process that is not achieved immediately, but rather through systematic work.
In this sense, for continuous improvement the following must be taken into account:

- The impact (positive or negative) of the planned actions.
- Assessment of the changes that occur during the implementation of the strategy's stages and actions, evidenced by improved teacher preparation.
- Redesign of the stages and actions based on teachers' suggestions to obtain superior results in relation to the treatment to scientific culture in the discipline of Molecular and Cellular Biology.
- Adjustment of the suggested topics in the methodological workshops depending on the needs and limitations of the teachers.
- Treatment evaluation to scientific culture in the context of the discipline of Molecular and Cellular Biology , which will allow for making the relevant corrections depending on the progress achieved, expressed in the cognitive, procedural and attitudinal aspects.
- Propose, update and make viable the actions for the treatment to scientific culture in the context of the discipline of Molecular and Cellular Biology .

Executed by: researchers and teachers of the Molecular and Cellular Biology discipline
To this end, a record will be kept of how the actions are carried out, in which the individual and collective evaluation criteria of the activity are expressed.
The results of this proposal served as a basis for postgraduate education, in the course: “ Trends, contradictions, and approaches to contemporary Biology” , belonging to the diploma: “ Integrative approaches in the teaching of Biology”; Furthermore, in the methodological work of the discipline collective .

Conclusions

This teaching strategy becomes an effective way to address scientific literacy in the teaching-learning process of Molecular and Cellular Biology. It develops critical and reflective thinking based on the relationship between the logic of science and the logic of the profession. It contributes to preparing biology teachers to navigate this process by contextualizing, applying, and assessing advances in the biological sciences and the impact of their biotechnological applications on daily life. Its actions can be coherently integrated into other teaching disciplines, providing a relevant and flexible alternative that enhances teachers' professional performance. Therefore, it is recommended to continue to delve deeper into the specific dynamics of scientific literacy in the teaching-learning process of science.

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