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La educación ambiental desde las clases de física: una estrategia didáctica
Environmental education in physics classes: a didactic strategy

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RESUMEN: El artículo aborda una estrategia didáctica, para la comprensión de las teorías físicas que son aplicadas a los fenómenos que ocurren en los Procesos Agropecuarios. Se utilizaron métodos teóricos, empíricos y estadístico-matemático en la explicación y revisión de datos bibliográficos para identificar las herramientas más efectivas. Los resultados revelan que, la estrategia contribuye a la sistematización de una conciencia ambientalista, energética y económica, y la explicación de los procesos agropecuarios.
Palabras clave: Estrategia didáctica; Procesos agropecuarios; Conciencia ambientalista; Hipótesis de progresión

ABSTRACT: The article deals with a didactic strategy for the understanding of the physical theories that are applied to the phenomena that occur in the Agricultural Processes. Theoretical, empirical and statistical-mathematical methods were used in the explanation and review of bibliographic data to identify the most effective tools. The results reveal that the strategy contributes to the systematization of environmental, energy and economic awareness and the explanation of agricultural processes.
Keywords: Didactic strategy; Agricultural processes; Environmental awareness; Progression hypothesis

Introduction

The school cannot “substitute political responsibility or scientific-technological knowledge, which are those that, in the last analysis, have to solve the multiple and complex existing environmental problems” (Cuello, 2003, p. 93), but it does have to develop educational processes that favor the appropriation of knowledge, behaviors, values and commitments that promote the active and democratic participation of the whole society in the solution and prevention of environmental problems.

The teaching-learning process of Physics offers opportunities that are not always taken advantage of to contribute to this aspect, among them the content of the subject contributes to the systematization of an environmental, energetic and economic awareness of the students, at the same time that it nourishes these aspects with the results of scientific research.

The use of didactic methodologies and strategies within a pedagogical model with sufficient motivation and reflection for students to become empowered in their real condition as agents of environmental change can be considered as a factor inherent to the teaching practice that allows generating in students a school environment conducive to the change of attitudes.

Therefore, the objective is to design a didactic strategy that contributes to the understanding of the physical laws and theories that are applied to the phenomena that occur in the soil, plants, animals and the atmosphere, considering climatological factors and their interaction with agricultural machinery.

Development

The National Environmental Strategy 2016/2020 issued by the Ministry of Science, Technology and Environment (CITMA) establishes as a principle and objective for the educational systems: To increase the integral environmental culture of the population, based on the development of knowledge, skills, attitudes, changes in behavior and modes of action that allow human beings to improve their relationship with the environment and contribute to the construction of a sustainable society. (CITMA, 2020)

Environmental Education is assumed as a permanent educational process is an integral part of the integral education of men that is expressed through sustainable development as a process of equitable improvement of the quality of life of people through which social economic growth is aspired and managed in a harmonious relationship with environmental protection, in such a way that it satisfies the needs of current and future generations. (García-Tejera *et al.*, 2016, p. 404)

The strategies implemented from the classrooms and aimed at the early stage of education, lack a real commitment, focused on the empowerment of children, not only with regard to environmental problems, but also before the existing alternatives for the conscious respect towards nature and the effective preservation of ecosystems. (Moreno-Fernández, 2020)

The so-called Environmental Education delivers to future generations a process of formative and transformative character linked to individual and collective relationships that should be exercised in a healthy way with the environment (Consuegra & Centeno, 2020).

Amado *et al.* (2019) & Zaldívar *et al.* (2019) address the environmental education, the first author in the initial training of Mathematics-Physics teachers; the second one in the Bachelor's degree in Physics Education, towards the protection of the environment.

For Simões *et al.* (2019), this derives from the imperative need for a pedagogical praxis impregnated by the corresponding didactics, to encourage an environmental culture that at the same time serves as a transversal axis in the various learning through which infants are guided in their career towards knowledge, towards future life, towards a complex world that requires the constant restoration of its natural balance.

There are many authors who have investigated this problem, we can mention the contributions of: Zambrano-Medina *et al.* (2020), Zaldívar *et al.* (2019), Velázquez *et al.* (2020), Velásquez (2019), Valdés, Martínez y Canachi (2017), Simões *et al.* (2019).

All of them addressing, in one way or another, to the introduction of the environmental dimension in the teaching-learning process.

In this sense, an elementary concern arises: How to contribute to the understanding of the physical laws and theories that are applied to the phenomena that occur in the soil, plants, animals and the atmosphere, considering climatological factors and their interaction with agricultural machinery?

In order to give answers to this question, the present research process is proposed, whose importance could be manifested primarily in its contribution to the systematization by the students of their environmental, energetic and economic awareness, while nourishing these aspects with the results of scientific research, measurement techniques, statistical processing and the elaboration of scientific reports, which favors their preparation in their actions, mainly in educational institutions.

The applied methods allowed knowing the existence of insufficiencies in the teaching-learning process for environmental education from Physics classes in the professional training of students of the Pedagogical School “José Marcelino Maceo Grajales”, from a virtual environment.

It is possible to consult enough theoretical supports that allow the intentional achievement of the profile of the graduate of the Pedagogical School, for the elaboration of the didactic strategy and

that the conceived ones contribute to the achievement of the extension of the profile of the graduate of the Physics career, at the same time that it puts him/her in better conditions to assume the challenge of carrying out his/her professional performance in educational institutions.

The strategy being didactic takes into account the teacher's activity to teach in indissoluble unity with the students' activity to learn and in the particular case of the pedagogical school for the performance of their future profession. This is seen as:

The transformation of the teaching-learning process in a subject, level, or institution taking as a basis the components of the same and that allows the achievement of the proposed objectives in a concrete time (Rodríguez & Rodríguez, 2004).

The proposed didactic strategy provides concrete didactic actions and operations for the application of physical laws and theories to the phenomena that occur in the soil, plants, animals and the atmosphere, considering climatological factors and their interaction with agricultural machinery, which is why it constitutes a working tool for the teacher.

Didactic strategy for the understanding of physical laws and theories

The didactic strategy for the understanding of the physical laws and theories that are applied to the phenomena that occur in the soil, plants, animals and the atmosphere, considering the climatological factors and their interaction with the agricultural machinery has as its mission: to improve the teaching-learning process of the subject of Physics for the development of environmental education in students.

Hence, the following are stated as **specific objectives**:

- To strengthen the preparation of teachers in actions and concrete didactic operations for the application of physical laws and theories to the phenomena that occur in the soil, plants, in animals and in the atmosphere, considering climatological factors and to their interaction with agricultural machinery.
- To develop the environmental education of the students of the pedagogical school in function of an environmental conscience in their ways of acting.

For the materialization of the strategy, four stages were conceived with their corresponding actions, in order to improve the teaching-learning process of the Physics subject for the development of environmental education in the students.

Stage 1: diagnosis and sensitization

Objective: to analyze the conditions, context, resources, main limitations and potentialities presented by teachers, as well as their alternative conceptions of environmental education.

Action 1: elaboration of diagnostic instruments.

Method: investigative

Procedures: independent work

Time of realization: 45 minutes

Form of implementation:

It starts with a general idea of improving or changing aspect(s) of the construction of physical knowledge in environmental education and the diagnostic instruments (teacher's diary and student's portfolio) were elaborated.

Form of evaluation: co-evaluation (the instrument will be socialized with experts).

Action 2: application of the diagnosis

Method: interview and surveys

Procedures: conversation

Time of implementation: 45 minutes.

Form of implementation:

An analysis of the reality of the context, and the objectives is carried out.

The daily didactic conceptions related to the teaching and learning of physics from the experience are identified through the interview of a group of students, teachers and directors and the consideration of an expert, then it is applied to the population under study and the information is codified by means of established categories to design the didactic strategy with its respective activities and learning resources.

The problem is described and diagnosed and the possible solution (hypothesis) and the system of short, medium and long term actions to intervene it are planned.

Form of evaluation: co-evaluation

Action 3: determination of the current state

Method: document analysis

Procedures: tabulation and interpretation of results.

Time of realization: 45 minutes.

Form of implementation:

The results together with the analysis of contents of the subject Physics and the local and global context of students and teachers allow establishing a hypothesis of progression, understood as, a proposal that can be continuously modified and that seeks to stimulate in teachers and students the desirable physical knowledge in environmental education.

In the collection of information, a teacher's diary will be implemented, describing the teacher's appreciations, analysis, possible alternatives and other observations of each of the didactic activities planned, developed and evaluated, and the student's portfolio where the work, tasks and other results of the construction of physical knowledge are filed.

Form of evaluation: elaboration of a report.

Stage 2 Training.

Objective: to offer different learning variants to analyze the link between physics and environmental problems.

This training will be carried out in the complementary activity shifts that allow systematizing and offering additional information related to the content of the subject.

Action 4 Scientific update

Method: explanatory

Procedures: dialogue

Time: 45 minutes.

Form of implementation

Discussion with specialists on the subject to address the current problems in the province.

Contrast the information received in class with that dealt with in other sources (books, articles, internet consultations, scientific journals, the press) based on the orientation received. Elaborate a summary of the main aspects that have attracted their attention.

Form of evaluation: Positive; Negative; Interesting.

Action 5 activity modeling

Method: explanatory

Procedures: Dialogue

Time: 45 minutes.

Form of implementation

The action consists of offering variants for the identification of the different laws, principles and theories of Physics that are manifested in agricultural phenomena and processes.

Different concrete situations will be presented in which the need for environmental education will be demonstrated.

Form of evaluation: Positive; Negative; Interesting.

Stage 3 Implementation of didactic alternatives

Objective: to apply the didactic alternatives that favor environmental education in the teaching-learning process of Physics in the pedagogical school.

Action 6 Alternative 1

Method: partial search

Procedures: Independent work.

Time: 45 minutes.

Form of implementation

The student is asked to write down the definition of the following concepts: agricultural processes, environment, environmental problems, physics, agriculture, agricultural mechanization, agricultural ecosystems, biomass, metrology, surveying, precision agriculture and soil conservation to facilitate the understanding and solution of the tasks to be solved from this.

Comment: students must be able to relate physics with other sciences, technology and society, which will allow a cognitive reflection of reality by gaining experience and a basic knowledge of the environment and associated problems.

Form of evaluation: co-evaluation

Action 7 Alternative 2

Method: Investigative

Procedures: Independent work

Time: 45 minutes.

Form of implementation

The student is instructed to write a summary where making reference to: the history of agriculture (ancient times, middle ages, modern times, contemporary times and current times of humanity); the relationship between physics, agriculture, agronomy, farming, biology, environment and society; the relationship between physics, science, technology, agricultural technologies (machines, equipment and agricultural tools), environment and society; no less than five environmental problems arising from the agricultural activity of man, as well as your proposal for solutions or mitigation of these.

Commentary: starting from the development of agriculture through the different stages of the historical development of mankind, as well as the relationship of Physics with other branches of science, technology and agricultural technologies in general and in particular of agronomy and not least the environment and how to contribute to mitigate environmental problems arising from the activity of man in the agricultural sector in general, students will be able to express how objects and situations of reality affect their needs and how they can modify their disposition for action.

Form of evaluation: co-evaluation (the instrument will be socialized with experts).

Action 8 Alternative 3

Method: Investigative

Procedures: Independent work

Time: 45 minutes.

Form of implementation

The student identifies at least five applications of concepts, principles, laws and theories of classical mechanics seen through concrete examples in work, energy and conservation laws; rational use of energy according to the energy balance in agricultural processes; mechanical energy; solar energy; hydraulic energy; wind energy; marine energy that are used in the solution of theoretical and

practical problems of the agricultural sector in general and agronomy in particular, using energetic methods.

Comment: choose any 5 elements of knowledge, among concepts, principles, laws or theories, mentioned in the objective of the task and relate them with their use and utility in the solution of theoretical and practical problems of the agricultural sector in general and of agronomy in particular, using energetic methods, to understand some implications and transcendence of the knowledge of Classical Mechanics in the solution of various theoretical and practical problems of the agricultural sector in general and of agronomy in particular, manifested in the history of mankind.

Form of evaluation: self-evaluation

Action 9 Alternative 4

Method: heuristic conversation.

Procedures: Exposition

Time: 45 minutes.

Form of implementation.

Ask the student to characterize the usefulness and importance of the five applications of concepts, principles, laws and theories of classical mechanics derived from your research activity in the study conducted.

Comment: students in the development of this task will develop actions individually and collectively in favor of the conservation of natural resources and directed to obtain a better quality of the environment.

Form of evaluation: Co-evaluation

Action 10 Alternative 5

Method: polemic exposition.

Procedures: Exposition

Time: 45 minutes.

Form of implementation

Write a commentary on the following questions: why, in essence, establishing nexus and cause-effect relationships of the five identified examples, whose usefulness and importance you characterized. The answer to the following question: can I apply what I have learned to new situations or relationships by establishing new nexuses and cause-effect essence relationships of other examples, in addition to those identified.

Commentary: this task relates the cognitive, affective and behavioral aspects, making it possible to evaluate the processes of environmental awareness.

Form of evaluation: co-evaluation

Stage 4 Periodic evaluation of the strategy

Action # 11: Feedback

Method: partial search

Procedures: heuristic conversation

Form of evaluation: co-evaluation

Realization time: 4h

Form of implementation:

It is suggested to listen to experiences that have generated a positive impact on environmental education. In addition, the teacher's evaluation of the students' learning management taking into account the self-evaluation of his/her own learning management and the teacher's self-evaluation of his/her own teaching management taking into account the students' evaluation of his/her professional performance.

Form of evaluation: heteroevaluation; self-evaluation and co-evaluation.

Results:

With the purpose of approaching the results of the applied proposal, we proceeded to carry out surveys to experts in the subject of environmental education and teachers with experience in Physics teaching, who offered recommendations that were taken into account and improved, from their point of view, the actions to be developed.

On the other hand, the teachers who have had the opportunity to use the alternatives proposed as part of the conceived strategy consider them very appropriate to contribute to the learning of

concepts, laws and principles of Physics from an environmental perspective that contributes to their modes of action as citizens and to their future professional performance, all of which was corroborated from the socialization workshops.

These spaces of collaboration and exchange conceived and designed for teachers and students allowed the exchange of audio (Podcast), video, information and study meetings via m-learning (videochat) applied by the distance work modality with teachers, the department head and some students where the following can be assumed as regularities, inherent to the application of the didactic strategy:

Teachers plan actions to enhance environmental education in the teaching-learning process.

The tasks proposed as part of the actions cover the developmental and educational components of the physics teaching and learning process.

They consider it necessary to strengthen the treatment of environmental education in the physics teaching-learning process and modified the didactic conception of this process.

Conclusions

Throughout this article, the treatment of environmental education in the teaching-learning process of the subject Physics in the Pedagogical School of Guantanamo has been explored in depth, showing that despite the regulations and indications, the work carried out in this sense is still insufficient, so it was necessary to elaborate the didactic strategy on the logical structure, through the implementation of various learning techniques with concrete actions to be developed by teachers and students, taking into account their real learning situation.

To evaluate the results of the didactic strategy, the socialization workshops and the consultation with experts and users were used, which show encouraging achievements in learning and teaching, highlighting the motivation and availability of both to promote a climate of reflection and assessment in the teaching-learning process according to criteria and practical implementation.

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