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Sistema de tareas docentes para potenciar la interdisciplinariedad en Fundamentos de la Física Escolar

System of teaching tasks to enhance interdisciplinarity in Fundamentals of School Physics

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Resumen

El presente artículo aborda un sistema de tareas docentes para potenciar la interdisciplinariedad en el área de las ciencias a través de los Fundamentos de la Física Escolar. La intención se encuentra en ofrecer un análisis de las ventajas que aporta un sistema de tareas docentes logrando niveles de aprendizaje superiores, acorde con los requerimientos de la sociedad, además de dinamizar y activar la participación de los estudiantes en el proceso docente educativo en el cual se elaboró un grupo de instrumentos y un sistema de indicadores para medir la tasa de avance en la enseñanza de la asignatura.

Palabras clave: Relaciones interdisciplinarias; Interdisciplinariedad; Tareas docentes; Sistema.

Abstract

This article deals with a system of teaching tasks to enhance interdisciplinarity in the science area through the Fundamentals of School Physics. The intention is to offer an analysis of the benefits of a teaching task system to achieve higher learning levels, according to the requirements of society, in addition to energizing and activating the participation of students in the teaching-education process in which a group of instruments and a system of indicators were developed to measure the rate of progress in the teaching of the subject.

Keywords: Interdisciplinary relations; Interdisciplinarity; Teaching tasks; System.

Introduction

The word interdisciplinarity first appeared in 1937 through Louis Wirtz. Before that, the National Academy of Sciences of the United States had used the expression "cross-disciplinary" and the Institute of Human Relations of Yale University had proposed the expression "demolition of disciplinary boundaries". In 1970, in a UNESCO text on the main trends in the development of the social and human sciences, Jean Piaget, in the article he commissioned, used the notion of "genetic recombination" of the new branches of knowledge.

In this sense, interdisciplinarity is a theme that is imposed in any scientific-technological process, to which pedagogues cannot remain oblivious. With regard to education, the teaching-learning process in Cuba, whether it is carried out in schools or not, should allow knowledge to be acquired in an integrated way, rather than in a partialized way, so that students can understand the holistic nature of the complex reality.

Taking into account the above idea, a diagnosis was made on the current state of interdisciplinary work in the Physics career at Guantanamo University, where the following instruments were applied: interview, survey, observation guides and documentary review, which showed the following irregularities:

- Lack of knowledge of the methodological theoretical support to achieve the formative purposes of a professional with a broad profile through the integration of knowledge from different areas of knowledge of the career.
- Failure to take advantage of the methodological work to achieve interdisciplinary links in the disciplines related to the academic year.
- The methodological activities developed in the department do not take the form of a system of actions that strengthen the establishment of interdisciplinary relations in accordance with the aspirations of the professional model in this career.

These irregularities are manifested in the contradiction that exists between the importance of the establishment of interdisciplinary relations from the methodological work with systemic approach for the teaching-learning process of Physics and its conception for the work in the area of knowledge, as one of the demands of the model of the study plan. Hence, it is proposed as an objective the elaboration of a system of teaching tasks to enhance interdisciplinarity in the Fundamentals of School Physics.

According to what has been expressed above, to carry out interdisciplinarity in any field of knowledge is a task that is not free of difficulties. The question lies in being able to carry it out in practice, taking into account that the interdisciplinary work carried out by a group of scientists is not the same as that carried out by a group of pedagogues when developing the teaching-educational process in a school. The interdisciplinary treatment requires a dialectical approach where the problem of objectives and contents are united in methods and forms of organization of these during learning and, therefore, the evaluation of this process.

From these conceptualizations, a marked intention of associating interdisciplinary relations in terms of knowledge, skill systems, system of values and convictions in relation to the world around us is evident.

That is why, since the 20th century, interdisciplinary integrative and/or globalizing proposals have been clearly identified in the field of the curriculum, which, although most of them did not achieve their practical generalization in the midst of highly fragmented and stratified societies, they did substantiate, experiment and demonstrate the need for and possibility of these forms of educational development.

The different disciplines have a volume of contents, therefore, how can we manage to break down the contents of each one, how can we group them, how can we integrate them? The realization of this colossal task is not easy.

In this context, are we willing to work seriously in favor of communication between the sciences, and do we give this objective the priority it needs to be viable? Hence the importance that requires the joint work of the disciplines that are part of the Physics career.

Development

Interdisciplinarity can be interpreted in different ways, being understood as a principle, a working method, and ways of organizing an activity, a methodological invariant and others, depending on the perspective of the position or context from which it is analyzed. If we want to make clear that interdisciplinarity is not only a theoretical, academic issue, but above all a practical one, linked to the way of thinking and acting of people and requires the conviction of these, also of other certain objective and subjective conditions, so it is not a fashion or a scheme that can be imposed, in this case, it is assumed as a principle to be applied through a methodological alternative in the Physics department.

In order to provide a solution to the problem posed and the need to carry out an interdisciplinary

work for the training of Physics personnel, the advantages of teaching based on interdisciplinarity and the close logical-methodological relationship between Mathematics and Physics are shown, in which several definitions are proposed and those assumed by the authors.

Nuñez J., (1994) when referring to the term interdisciplinary relations, defines it as an encounter and cooperation between two or more disciplines, where each one contributes with its conceptual schemes, ways of defining problems and research methods. This term is assumed for the development of this work.

A term that is of great importance is interdisciplinarity, which has been approached and defined by different authors and below are some of these definitions:

Interdisciplinarity: It represents the integration between two or more disciplines, product of which, they enrich their conceptual frameworks, their procedures, and their research teaching methodologies. (Perera Cumerma, 2000)

Interdisciplinarity: It is the relationship of each discipline with the objective and among them; it refers to the constructive relationship of a specific object and proper of all of them. (Alvarez 2004).

Interdisciplinarity: It is an approach that makes possible the significant process of mutual enrichment of the curriculum and the learning of the participants, which is achieved as a result of recognizing and developing the existing relationships between the different disciplines of a study plan, through the components of the didactic system and that converge towards an exchange that favors mutual enrichment from encounters that generate the reconstruction of scientific knowledge. (Addine 2000)

In the definitions of interdisciplinarity, common points of view are shown, such as links that are established to achieve common objectives among the different disciplines, existence of complex problems in the pedagogical reality that needs an integral approach for its solution, coordination, cooperation and interrelation link, way of thinking, points of view that should enhance the different disciplines, didactic processes that are considered key for its implementation.

Taking into account Castellanos (2002), who defines teaching tasks as: Any learning effort or work that has an objective, a specific content and procedure that involves the student in the understanding and execution, decision making and interaction while learning and in its evaluation.

Assuming the concept given by Nionov (1998) of system: Sets of elements closely linked to each other, which constitute relatively independent units. The simplest systems are grouped together to form more complex ones.

Pedagogical training programs must prepare teachers, through undergraduate studies in more than one specialty and offer in-depth studies to practicing teachers, in which the interdisciplinary approach is developed as a work philosophy.

Teaching based on interdisciplinarity has a great structuring power since the concepts, theoretical frameworks, methods, skills and others with which students are confronted, are organized around more global units, conceptual and methodological structures shared by several disciplines, thus acquired learning transfers in another disciplinary framework and they are better able to face problems that transcend the limits of a particular discipline and to analyze and solve new problems, which are considered as advantages of interdisciplinary methodological work.

From the analysis of documents of the different study plans, the evaluation of the curricular conception, the general character of the programs, the disciplines that make interdisciplinary links possible and the characteristics of the year structure, the following historical tendencies in the establishment of interdisciplinary relations in the career are observed.

For the realization of the curricular work there is a set of sciences that play an important role, since they serve as theoretical and methodological foundations; among them are psychology, pedagogy and the specific sciences that shape the content of teaching. In addition, there is a system of legal foundations, norms and regulations that originate in the organizations of each country and that guide and indicate the official and state policy in this regard.

From the epistemological point of view, it builds a reflection on "knowledge", on its validity, and on the role of researchers in today's world.

The teaching staff must be qualified to assume within their discipline the training of the student in the scientific research activity and that the student can interact with both contents, establishing a dialectical relationship between the logic of the discipline they teach and the logic of the research process, which implies assuming it from the design of a system of circular teaching tasks.

For the determination of the epistemological framework, the educational process was analyzed as a whole, where it is basically based on a cognitive theory that provides the essential foundation for organizing the student's activity in the learning process. The epistemological basis alludes to

the subject-object interrelation in the process of activity, to the relationship of knowledge with reality, to the criteria of authenticity and veracity of knowledge and to the relationship between the sensory and the logic of reflection.

Interdisciplinarity does not lead to the process of absorption of some sciences within others. On the contrary, it produces a qualitatively superior leap in the knowledge resulting from this process, trying to overcome the fragmentation of reality by specialization, a requirement for the progress of scientific progress, but it tries to overcome unilateralism and the danger of dispersion (Pérez, 2000) Interdisciplinarity: some epistemological reflections, 23p.

From the pedagogical point of view, they describe the principles and characteristics of the pedagogical trend being worked on and provide some guidelines for the organization of the teaching and learning process.

One of the ways to guarantee professional orientation in Higher Education are the curricular strategies. These make it possible to concretize at the year and discipline level the more general objectives of the Professional Model. There is a director program of Pedagogical Professional Orientation.

The subjects of the pedagogical professional training process are required to be willing to assume changes in their different ways of acting. A climate of cooperation and flexibility is indispensable in the establishment of links between disciplines and subjects and between these professional problems and others that may arise in the educational practice of the students, especially those who fulfill the role of tutor teachers. It is in the collective work where the ethical-professional traits and qualities of teachers are revealed, where their collaborative attitudes are manifested through exchange, cooperation and coordinated action in the processes involving pedagogical professional training. Methodological and scientific work are the ways of concretization of these attitudes.

Advantages of teaching based on interdisciplinarity

- It eliminates the boundaries between disciplines, eradicating the gaps in the students' knowledge, showing them nature and society in its complexity.
- It increases the motivation of students, being able to apply their knowledge in different subjects of the different disciplines, developing more intellectual and practical skills, as well as independence and creativity.

- Standards of conduct are formed, which become habits, by achieving the coherent and systematic action of all educational influences, in accordance with the system of results required by society.
- It awakens the teachers' interest in research and the search for new knowledge by feeling the need to integrate the contents of the different disciplines, contributing to the formation of an efficient methodological work of the year, department and career collectives.

In the advance of knowledge towards interdisciplinarity, these have manifested themselves in various ways: as transposition of the method from one science to another, transfer of concepts and theories belonging to one science to different sciences, and the search for a trans-scientific principle, capable of unifying or articulating the sciences and serving as a method for the development of knowledge. It is in the latter, where we place philosophical knowledge, whose theoretical presuppositions can be applied by its universal character to any sphere of scientific knowledge, constituting also a method of reproduction of reality.

In philosophy, epistemological, axiological and anthropological questions converge, from which we can have an integrated conception of the world, and in this sense we can affirm that the transdisciplinary level of the highest degree of university corresponds to philosophical knowledge, even when there are intermediate levels of generalization, identifiable with the basic sciences.

As a logical consequence of the historical-logical analysis carried out on the evolution of the problem, the systematization of the main theoretical assumptions used as referents in our research and taking into account the current state of the problem, a system of actions to enhance the establishment of interdisciplinary relations in the Physics career is presented as a result.

Physics and Mathematics have a close logical-methodological relationship that can be summarized in the following facts:

- Mathematics in its historical development has been the answer to transcendental problems of nature, society, and thought. In particular, as an exact science it has become the logical-deductive apparatus of Physics and the basic model for the resolution of its problems.

- The interpretation of various physical phenomena has led to the development of new mathematical theories just as the development of new physical ideas has given practical meaning to the existence of already developed mathematical theories.
- Mathematics provides a numerical and symbolic language that makes it possible to express a series of relationships that exist in nature.
- The mathematization of scientific knowledge occurs when real objects are replaced by abstract objects and the concrete relations between these objects are replaced by mathematical relations.
- In the particular case of Physics, mathematization occurs in two fundamental moments: when the mathematical problem that models or corresponds approximately to the physical fact is chosen, and then when new mathematical forms are elaborated that allow the model to be perfected.
- Typical situations of physical-mathematical teaching: mathematical modeling of scientific knowledge, calculation of magnitudes, elaboration of mathematical models.
- The procedures used by Physics in the solution of problems are generally contributed by mathematics and curricularly it is taken into account that the study of such mathematical algorithms precedes the study of the physical content in question, but not always the physics teacher reveals in his teaching performance its essential characteristics including the technical language to be used; for example, when constructing and/or interpreting a graph of a function, which would be an important contribution to the achievement of interdisciplinarity in the subjects of the area.

These historical links between the sciences allow establishing the guiding ideas to be taken into account in the elaboration of a system of actions for the establishment of interdisciplinary relations from the Fundamentals of School Physics Discipline, are the following:

- The general objectives stated in the model of the professional of the Physics Career directly related to the contents of physics, mathematics and special didactics of these subjects determine the sense and intensity of the methodological actions to be developed for the establishment of interdisciplinary relations, which are the disciplines that with greater intensity affect the establishment of interdisciplinary relations given the intentionality explicit in the objectives exposed for the formation of the professional in the first year of the Physics Career.

Fundamentals of School Physics

The objective of this discipline is to ensure that students are able to understand and apply the concepts, laws and physical theories studied in high school, related to mechanics, molecular theory, thermodynamics, electromagnetism, optics, oscillations and waves and modern physics in the resolution of exercises and problems of qualitative and quantitative character taking advantage of computer resources with the essential purpose of a tool for problem solving. In addition, this discipline should serve as a model of performance improvement for students in situations of concept formation and experimental work.

Fundamentals of School Mathematics

This discipline aims to provide students with the conceptual basis that underlies the contents of upper secondary education, both from the point of view of classical logic, set theory, numerical domains, relations, functions and the theory of equations, as well as synthetic and analytical geometry of the plane. At the same time, it is intended that they develop more skills, habits, abilities, qualities, convictions and aptitudes in the resolution and formulation of problems with a level of difficulty and complexity equal to or higher than those faced in the preceding levels of education, taking advantage of information and communication technologies, developing ways of working and mathematical thinking such as combinatory and statistics.

Didactics of Mathematics

The discipline offers the theoretical and methodological and specific foundations for the management of the educational and teaching-learning process of mathematics in higher education, enables the diagnosis and monitoring of learning in the subject from a developmental approach; makes available ways, methods, procedures and means of teaching - including those supported by ICT - varied, thus the criteria for their selection in various contexts, applicable to the fields of action of the professional who aspires to form and contributes to the formation of qualities, aptitudes and convictions.

Didactics of Physics

The discipline Didactics of Physics, through its instructive, developmental and educational functions, is aimed at preparing future teachers in the theoretical and practical order to successfully perform their pedagogical work in higher education, with the ability to deepen and critically assume the content of the programs and texts of this area of scientific knowledge, creatively applying the acquired preparation. This discipline has a core of its own contents,

derived from the mother science and uses, as important tools, among others, the theory of knowledge, general didactics and psychology. Particular attention is paid to the fundamentals of the process of formation of physical concepts, to problem solving, to experimental work, to the relationships Science, Technology, Society, Environment and to the use of computer resources as a means of teaching and as a tool for problem solving.

Application of the system of teaching tasks in Unit 1. The universe in which we live.

Unit 1. Physics and the universe we live in.

Objectives:

- To argue the importance of deepening the study of Physics for other sciences, technology, society and in general, culture.
- Characterize the universe in which we live in terms of: main systems that compose it, its dimensions and main magnitudes.
- Analyze the main systems, interactions and changes in the universe studied by physics, exemplifying the unity that exists behind the diversity in the universe.
- Explain the importance of physics for the scientific and technological development of the country, arguing the country's position regarding the scientific-technological development relationship and global problems.
- Explain what are the main activities the of teacher of physics in contemporary society.

This is an introduction to the Physics course, based on the systematization of the contents acquired in previous grades, it is intended to expand on them and present the main topics of study at this level of education.

The material has been elaborated to guide the methodology to be followed by teachers in the work with the different units of the course. The system of unit tasks and the respective methodological comments and solutions are included.

Example of interdisciplinary teaching tasks

Task # 1

What are the dimensions of the universe? How did the universe come into being?

- Do a search in the library of the Substance and Field Software to solve the above questions.
- Present the results in a digitized report in Word format, Arial 12 font, 1.5 spacing. The report will have at least three pages with introduction, development and conclusions.

It is important to discuss the importance of the study of the universe in which we live for the formation of an integral general culture of citizens. A brief review of the most known and significant theories concerning the origin and evolution of the universe should be given. Questions concerning the origin of the universe are currently one of the frontiers of research in contemporary science.

All matter, including space and time, was at a point, a singularity, at a very high temperature. When the great explosion took place, matter-energy, space, time began to expand and the temperature of the universe decreased. This descent propitiated the separation of matter and energy, the formation of protons, neutrons, from quarks and electrons, atoms and molecules were formed. The union of dust and stellar matter led to the formation of the solar system.

This task favors the preparation of students in research activities responding to the actions of the curricular strategy in relation to the use of Tics in the career.

Searching for information in the library, using the word processor, relying on computer skills, the use of the Physical Software and e-mail to present the results of teaching tasks.

It favors the actions of the mother tongue strategy in the career; the activity helps written and oral communication so that ideas are expressed clearly and coherently.

It reveals the social result and the result in itself of the facts, phenomena, or process of study, enhancing the formation of educational actions, in the unity of the affective with the cognitive, highlighting the significance of the object of study for the student.

Task # 2

Scale representation of the mega world: Design a situation using the Interactive Physics Software of the sun, the quarks.

This assignment aims to represent at scale some systems of the mega world and their comparison with ordinary dimensions for man. It has its antecedents in the eighth grade physics course where it was solved qualitatively. It is important to highlight the knowledge achieved towards the infinitely large and the infinitely small.

Employment and support of computer skills for the use of Physics Software to model physical situations.

It should be discussed what a scale representation consists of through examples known to students, such as maps, design templates, mock-ups, others. The use of mathematical formulas, their clearances and the analysis of units of measurement, it is important to work with the power

properties that are made in the proposed task by the teachers. In general, the scale factor is equal to the ratio of the distance to be represented and the real distance (fe=Da/DR), that is, how many times the real dimension will be reduced in that scale. If the diameter of the earth (dr=1.2*10 7 m) equals one millimeter (10-3m), the scale factor is:

$f_e = \frac{10-3}{1,2*10\ 7} = 8,3*10^{-11}$

Sun diameter = fe .ds

Micro world

The real dimension of the quark is of the order of 1018 m and applies to one millimeter. The scale factor for representing the dimensions of other bodies is:

fe⟦=10/⟦10⟧^(-18) ⟧^(-3) =1015.

Task # 3

What is the fundamental purpose of science and technology?

This task should take up the idea of the need for science to know in depth, beyond appearance, certain systems and changes in the universe. In the case of physics and other natural sciences, natural or man-made systems and changes are studied. The purpose of science is to deepen the knowledge of different systems, interactions and changes in the universe, with the purpose of satisfying human, practical and spiritual needs.

Technology is related to the practical, transforming activity of man and emerged long before science. It is important for the teacher to confront, through examples, the reductionist view of technology as a mere application of scientific knowledge.

In its close relationship, science provides fundamental knowledge for multiple branches of technology, electronics, materials engineering, aeronautics and cosmonautics, in turn, the modern resources created by technology: computers, calculators; microscopes, telescopes, new materials, satellites, particle accelerators, are an indispensable requirement for the development of science. An illustrative example of this interrelation is that today scientific activity is inconceivable without the use of new information and communication technologies.

In discussing this task, it is necessary to highlight the emergence of new branches (biophysics, bioinformatics, optoelectronics, and molecular medicine) and the interdisciplinary and integrative nature of science to face the complex problems of reality. **Conclusions**

The study of the interdisciplinary conception makes it possible to analyze and understand the historical evolution of the establishment of interdisciplinary relations in the different curricula, in addition to redesigning methodological work strategies at different organizational levels.

The proposed system of teaching tasks is feasible and valuable after its implementation; it is coherent and logical, achieving significant changes in the different ways of acting of teachers; it constitutes an instrument for teachers to observe the establishment of interdisciplinary relations from a different point of view.

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