Revista Varela, ISSN: 1810-3413 RNPS: 2038
Vol. (20), No. (56), art (06), pp. (218-233), mayo-agosto, 2020
Universidad Central "Marta Abreu" de Las Villas,
Carretera a Camajuaní km 5,5. Santa Clara, Villa Clara, Cuba. CP 54830
http://revistavarela.uclv.edu.cu, revistavarela@uclv.cu

THE TEACHING TASK: A WAY IN ORDER TO IMPROVE THE LEARNING OF PHYSICS IN THE TEACHERS FORMATION

LA TAREA DOCENTE: UNA VÍA PARA MEJORAR EL APRENDIZAJE DE LA FÍSICA EN LA FORMACIÓN DOCENTE

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ABSTRACT

Scientific problem of research that appears in this paper was the necessity of changes in Physics teaching, given limitations detected in students’ learning of the Pedagogical Career at Central University “Marta Abreu" of Las Villas. As solution, was designed and implemented a didactic proposal related with the organization the teaching-learning process of physics, through teaching tasks in which are used: the problematic approach, the experimental work, teaching aids, techniques of group work and the diversification in the tasks forms of presentation. Pedagogical pre-experiment was used as experimental design, which was developed in the Physics III subject of Pedagogical Career in Mathematical-Physical Specialty and theoretical, empirical, mathematical and statistical methods were used in the application of proposal. Collected data analysis showed that the assimilation of the physical contents had a more favorable behavior after the introduction of proposal.

RESUMEN

En este artículo se presenta la investigación desarrollada en la Universidad Central “Marta Abreu” de las Villas, cuyo problema científico estuvo relacionado con la necesidad de cambios en la enseñanza de la Física, dadas las limitaciones detectadas en el aprendizaje de los estudiantes en formación pedagógica. Como solución a la problemática planteada, fue diseñada e

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Aprobado: 10 de abril de 2020

implementada una propuesta didáctica para la organización del proceso de enseñanza-aprendizaje a través de tareas docentes, en las que se emplearon: el enfoque problémico, el trabajo experimental, el uso de medios, las técnicas de trabajo grupal, así como diversas formas de presentación. La propuesta se aplicó mediante un pre-experimento pedagógico en la asignatura Física III de la especialidad Matemática-Física, y fueron empleados diversos métodos de investigación, tanto: teóricos, empíricos, matemáticos y estadísticos. El análisis de datos recogidos durante la implementación, demostró que la asimilación del contenido físico tuvo un comportamiento más favorable después de la introducción de la propuesta.

PALABRAS CLAVE

Tarea docente, aprendizaje de la Física, formación docente, pre-experimento pedagógico.

KEY WORDS

Teaching task**,** physics learning, teacher formation, pedagogical pre-experiment.

INTRODUCTION

The necessity of transformations in sciences teaching has a significant importance at present, as a result of the scientist-technical development and its impact in the modern society. The United Nations for the Education, Science and the Culture (UNESCO) and the Iberoamerican States Organization (OIE), among other international organizations, are working in several programs and research projects to improve the quality of the teaching-learning process of sciences, pointing out its relevance in the formation of competent citizens, who can reflectively act in a society marked by the increasing scientific and technological changes (OEI, 2012; UNESCO, 2005).

On the other hand, the need of transformations in teaching of sciences has significant importance, if it considers that the study of the scientific disciplines in the scholastic scope constitutes a problem that has a special concern at present, both in the Latin American area and in developed countries (Gil, 2005).

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Students limitations in understanding the scientific knowledge, in the development of skills in problem solving and the experimental work, as well as in the motivation and the development of positive affective experiences towards the scientific subjects, in particular in physics, are widely recognized (Tan, Heng, y Tan, 2013; Huey-Por, 2007; Greca y Moreira, 2002) these limitations generally affect the academic performance of a high number of students and the consequent lack of candidates for higher scientific studies (Gil, 2005).

Precisely, the *scientific problem* of this research was the necessity of changes in the physics teaching, given the limitations detected in students' learning of the Pedagogical Career at Central University "Marta Abreu" of Las Villas. As *solution* to the mentioned problem, were designed and implemented a didactic proposal related with the organization of the teaching-learning process of physics, through teaching tasks directed towards to the improvement of students' learning, in which are used: the problematic approach, the experimental work, teaching aids, techniques of group work and the diversification in the tasks forms of presentation.

TEORETICAL FRAMEWORK

The term *task* has different meanings in pedagogical and psychological literature. In the system of knowledge developed by psychology, the task is related to the activity and the communication, it is determined by the intentionality (since it responds to an objective) and the operationally (since it responds to the conditions); orientation, execution and control constitute the functional aspects of the task which are showed in it solution (Leontiev, 1981; Bermúdez y Rodríguez, 1996; Talízina, 1988; Talízina, 1985).

In the analysis made above, psychological aspects related to the task in general sense have been treated, nevertheless, it is necessary to point out the concept of the task from the didactics point of view.

The most updated ideas about didactics consider the student as the center of the teaching-learning process (Kramarski, 2013; Tausan, 2012; Michalsky, 2012; Zierer y Seel, 2012; Feicke, 2012; Meyer, 2010), from this perspective the *teaching task* is considered as the situation that students must solve in order to promote their learning. Therefore, it is necessary to organize

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students' activity, creating tasks that promote and increase their development. For it, the tasks must contribute to: the structuring of relations, the analysis of contradictions, and the search of alternatives in order to solve the problems, as well as the development of intellectual instrumentations among other aspects, favoring students to arrive at generalizations and judgments under the direction of teachers.

In the particular case of this research, it is important to take into account researches, innovations and pedagogical experiences devoted to the study of problems in the learning of sciences, and in physics in special, which have offered significant contributions for the enrichment of sciences didactics at different educational levels. Some of the contributions will be mentioned below that have been used in the teaching tasks of the proposal.

Science-Technology-Society (STS) studies have permitted to recognize the importance of encouraging students to learn scientific contents that can favor their critical interest towards the role of science and technology in their lives (McDonald, 2014; Sanz y López, 2012; Hodsona, 2003; Kolstoe, 2000; Vilches y Furió, 1999). The social -cultural-environmental dimension, aimed at achieving a process committed to educate future generations in principles of a sustainable development, is also emphasized in these studies (Papadouris, 2012; Schindel, 2012; Macedo, 2006; Macedo, 2008; Evora y Asencio, 2006).

The consideration of the scientific knowledge process in the teaching-learning process has also had an increase at present, from works made by numerous researches in the field of science education (Papadouris, 2012; Schindel, 2012; Macedo, 2006; Macedo, 2008; Evora y Asencio, 2006). Many of them emphasize the importance of the use of scientific procedures and in the role of the school experiment for the development of scientific thinking (Abdullah, Malago, Bundu, y Thalib, 2013; Al-Ahmadi y Reid, 2011), by its contribution to elevation of the capacity of reasoning and argumentation (Sasson, 2002).

The use of Information and Communication Technologies (ICT) in the teaching-learning moreover constitutes a relevant issue; multimedia products, hypertexts, platforms of learning, statistical packages, platform of forums, data bases, applets and others, have ample didactic

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possibilities by his dynamic character, since they permit the interactivity and the storage of the information (Olympiou y Zacharias, 2012; Mababu, 2012.

METHODOLOGY

Methodologic design

The quantitative methodology was employed in this research, although qualitative methods were also used in order to complement the analysis of the data. Analytical-synthetic, induction-deduction, systemic-structural, modeling, observation, interviews, document analysis, experts judgment, pedagogical pre-experiment, among others were the methods used. Betwen mathematical and statistical methods were applied: the graphical method to analyze the values obtained in the indicators and the test of Wilcoxon, to analyze statisticaly data collected for each indicator, before and after of the experiment.

The pedagogical pre-experiment was used as experimental design (Sampiere, Col y Lucio, 2006), in Physics III subject of Pedagogical Career in Mathematical-Physical Specialty at Central University “Marta Abreu" of Las Villas, in a group of fourteen students; this group was considered as both control and experimental.

The teaching tasks in the teaching-learning process of physics were selected as independent variable and assimilation of physical contents acted as dependent variable.

Characterization of the proposal

As it were explained previously the didactic proposal was related with the organization of the teaching-learning process of physics through teaching tasks directed towards the improvement of students’ learning. Next, a brief characterization of the proposal from theoretical plane will be made.

The teaching task is related with changes or transformations that take place in students during its solution; each task contributes new elements in the students’ learning (knowledge, abilities, feelings and values) which are integrated until the objective is reached.

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In the measurement that the productivity of the tasks is increased, the process will be able to reach a greater quality in the students' learning results. The increase of task productivity depends of the resources available for stimulation of the affective and cognitive processes of the students in close interaction, so that these processes are harnessed to each other.

There are many aspects to increase productivity of the task; in special, within the context of this research it will be analyzed: the problematic approach, the experimental work, teaching aids, techniques of group work and the diversification in the forms of presentation of the tasks.

The problematic approach of the task activates affective and cognitive processes (specially, the thought) when contradictions appear. Problems may be present in different stages of the process; so, in the study of new content, during the process of initial formation of certain system of concepts, laws and theories, the problems can be stated by the creation of situations, those should present contradictions and to be novel and attractive in order to stimulate the students to solve it. On the other hand, the problems may be also present in the stage of the process whose essential objective is to develop abilities (theoretical or practical) by application of knowledge, contributing to consolidation and deepening of this knowledge.

Experimental work plays a key role in productivity of the task, not only because it can create student's affective motivations and positive experiences, but also by its contribution to develop intellectual mechanisms, especially, the perception and the memory. Productivity of the experimental tasks can be increased significantly if the potentialities of the experiment for the treatment of problems take advantage; this way of presenting the experiment increases the affective and cognitive processes. A resource that can be used in some occasions is the mental experiment, which also contributes to activation of the imagination process.

The tasks related to the experiment depend, among other issues, on how it is organized; if the experiment is developed by the teacher, the students will have as tasks: observation and analysis or explanation. In another variant, students individually or collectively make the experimental work, as well as the rest of the previously indicated activities; this is a very productive way to

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organize the experimental work although its accomplishment is not always possible because of limitations of resources.

The use of teaching aids is an effective way to increase the productivity of tasks, mainly by the increase of perception. The evidence not only can be related with the observation of the phenomena by direct form, but as well involves the audiovisual support that through multiple teaching aids can be used in class. The evidence besides includes abstract elements that can be concreted through symbols, graphic, tables, and schemes, among others.

However, the role of teaching aids not only is given in presenting student the objective reality or its material representations, but also in truly providing the bridge or bond between these concrete perceptions and logical process of thought; for that reason the productivity of use of teaching aids increases remarkably when it is combined with problems.

As teaching aids, the use of ICT has nowadays an extraordinary boom in the simulation of phenomena, the automation in data collection and their processing in laboratory experiments, among others. Video and films used as teaching aids have a particular meaning by its role in the scientific update and its potentialities for educative work and cultural formation.

The use of group work techniques contributes to increase task productivity, by the interactions established among the members of the group; they remarkably reinforce affective and cognitive processes. The practice of group discussion permits improving the knowledge of members about the debated issue; as result of the discussion, accumulative effect can take place, an idea leads to another one and thus new ideas arise and associations from ideas that a single person could not have reached. In addition, this has a significant influence on the activation of the memory, since that information is retained with more force when it is expressed in front of other people.

Between variants in the group work are point out, the work in small groups or teams, in which students solve certain tasks that afterwards are discussed in class; therefore, the use of participative techniques in consolidation of knowledge, from game situations are very effective.

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The diversification in the forms of presentation of tasks permits training students in the analysis of diverse situations and extent their sphere of action, contributing to increase the level of generalization of assimilated contents. For example, the task can be presented as:

- Debates of relevant social thematic.
- Discussion of materials printed coming from different sources: texts of subjects, printed and digital encyclopedias, Internet, journals, newspapers and others.
- Researches of social impact of the contents in contexts near to student
- Controversial socio-scientific issues' discussion.
- Problemic situations: theoretical, experimental and/or with the use of mental experiments and informatics resources.
- Situations related to daily life facts.
- Situations presented through: drawings, schemes, phrases, tables, videos and other teaching aids.
- Search for information from different sources.
- Situations that demonstrate interdisciplinary relations.
- Problems with open and closed statements.
- Theoretical problems with experimental support or other teaching aids.

So far, we have presented some of the fundamental theoretical aspects of the proposal. It is important to emphasize that the proposal was evaluated through the specialists' judgment, which emitted positive criteria. The specialists also offered suggestions that contributed to the enrichment of the proposal.

Implementation of the proposal

Based on the ideas expressed in previous section, teaching tasks in concrete physical content

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were elaborated. As it were explained previously the teaching tasks in the teaching-learning process of physics were selected as independent variable and assimilation of physical contents by students, acted as dependent variable. The indicators and scales to measure the dependent variable will be described below.

Indicator 1: Mastery of the physical concepts.

Low level (1): They can select the fundamental concepts of the subject but they present insufficiencies in their characterizations and relations.

Medium level (2): They can select and characterize the studied concepts but they present insufficiencies in the relations of subordination among them and in their application.

High level (3): They can select and characterize the studied concepts and can apply them in different situations.

Indicator 2: Mastery of the physical phenomena and laws.

Low level (1): They can describe only some characteristics of the studied phenomena presenting insufficiencies in the establishment of the laws.

Medium level (2): They can explain the phenomena and the laws that are pronounced of qualitative form and to value their meaning, but presents insufficiencies in the quantitative analysis and their application.

High level (3): They can explain the phenomena and the laws that are pronounced both qualitative and quantitative form, so as to value his meaning and to apply them in different situations.

Indicator 3: Solution of physical problems.

Low level (1): They present insufficiencies in the interpretation of the information and in the modeling and they cannot solve the problem.

Medium level (2): They can process the data and make the modeling, although they present insufficiencies in the hypothesis emission, in the elaboration and execution of strategies of

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solution in some situations.

High level (3): They are able to process the data, to make the modeling, to emit hypothesis, to elaborate and to execute strategies, as well as to solve the problem in different situations.

Diverse instruments were elaborated to measure indicators; between them were: guides of observation, guides of interviews, questionnaires, tests, self-evaluation registries, among others. These instruments were applied in the stage initial and throughout the pedagogical pre-experiment.

RESULTS AND DISCUSSION

Quantitative analysis

Indicators were evaluated from the data collected in application of instruments. The results of evaluation are showed in Tables I and II.

Table I

Indicators before the experiment

Indi / No	1	2	3
1	1	2	2
2	1	1	1
3	1	1	1
4	2	2	2
5	1	1	1
6	1	1	1
7	1	1	1
8	2	1	1
9	2	1	1
10	1	1	1
11	2	2	1
12	1	1	1
13	2	2	2
14	2	2	2

Table II

Indicators after the experiment

Indi / No	1	2	3
1	3	3	3
2	2	2	2
3	3	3	3
4	3	2	2
5	2	2	2
6	3	3	3
7	2	2	2
8	2	2	2
9	3	3	3
10	2	2	2
11	3	3	3
12	2	2	2
13	3	3	3
14	3	3	3

The comparative analysis between data that appear in tables, it is observed that 12 students increased their levels in all indicators, whereas a student reached a superior level in two indicators and one student increased in an indicator maintaining the medium level in the rest.

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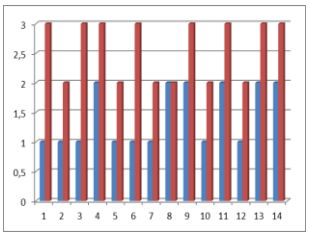
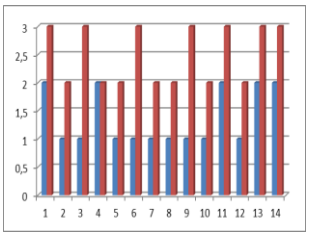
The comparison between indicators for each student before and after the experiment can also be observed in the graphs (1, 2 y 3) that appear below.



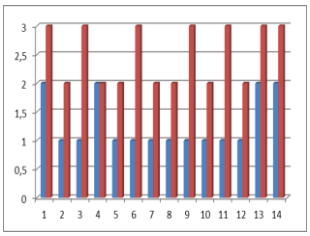
Graph 1

Indicator 1 (b-a)



Graph 2

Indicator 2 (b-a)



Graph 3

Indicator 3 (b-a)

Wilcoxon test was used in order to analyze statistically the data. For the comparison of the data the following hypotheses were considered:

Ho: There are no significant differences in the experimental group after the pre-experiment with respect to selected indicators before.

H1: The experimental group has a more favorable behavior after the pre-experiment in selected indicators.

For application of the test it was considered as level of meaning 0.01 that is why the trustworthiness level was 99%. Results obtained for each indicator show that in all cases there are significant differences between data, reason why hypothesis accepts alternative (H1) that considers that behavior of each indicator is more favorable after the pre-experiment with respect to the beginning of the same one, with a trustworthiness of 99%.

According to what was mentioned before, we can conclude that dependent variable assimilation of contents had comportment more favorable after the pedagogical pre-experiment with respect to beginning.

Qualitative analysis

The dependent variable was also evaluated from qualitative point of view. For it, personal elaborations offered by students in application of instruments were considered, which showed satisfaction by the developed tasks.

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Here are some comments made by students:

"I have obtained abilities and it has served to me to explain better the phenomena from physical point of view ".

"One better understanding of situations has facilitated me to consider the tasks; in new situations I have been able to appreciate an improvement"

"I have managed to exceed some of the difficulties presented ".

"All the activities have been fruitful, but more interesting there are the experimental tasks, since they allow seeing the phenomenon, one of tasks in which it is learned more".

"The problems were to me more interesting from opened statement, because it offers a general perspective of subject that is treating ".

"I liked much experimental tasks, because it teaches us to be creative and to deepen into bibliographical study ",

"It excited me to solve the proposed tasks"

"I have increased my effort towards the study of subject ".

CONCLUSIONS

An integral analysis of the obtained quantitative results in evaluation of selected indicators, so as the analysis of content and triangulation of the qualitative data, permits or makes it possible to appreciate that dependent variable assimilation of the contents has a more favorable behavior after the pedagogical experiment with respect to beginning of the same one.

It is important to emphasize that research also was validated by a group of 30 experts who offered favorable criteria about proposal, which contributed to diminish the influence of subjectivity of researcher. We were also recognized the limitations of the selected experimental design, which has a degree of minimum control, that is why, other variables could have existed, (strange) able also to generate changes.

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However, perhaps the fundamental contribution of this research can be its methodology value, because it permits to show how didactic proposal operates and its possibilities of application in teaching-learning process of physics, as well as in other disciplines of the scientific area. Moreover, it is important to emphasize, in importance of the subject treated in teachers formation, not only it represents the design and execution of teaching tasks as self-abilities of the educational profession, but also in the value of the didactic proposal as model of performance in his future work as a teacher.

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