An alternative for the teaching and learning of the heat transmission topic with base in the directed research for high-school students

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Abstract

In this work are presented the results of an educational research realized for the teaching and learning of key concepts of the Heat topic with high-school students. The objective was to test the didactic strategy called Directed Research and its effectiveness to acquire the scientific concepts of Heat, Temperature, Heat Transmission and a scientific learning. The recollection of these data was made during the 2010-2011-A semester with 26 first-cycle-high-school students from the Instituto de Educación Media Superior IEMS (pre university education System) that attended the subject of Physics I. The students were divided in two groups, the first performed the task as the experimental group, where the Directed Research was applied and the second was the control group, and the teacher that steered this part of the students was asked to develop the course in a traditional way. This research was evaluated by a test applied before and after developing the mentioned topic with the didactic strategy. The test is an adaptation of an assessment instrument approved in Silveira & Moreira's educational research to detect conceptual mistakes in the proposed theme.

Keywords: Heat transmission learning, Directed Research, and Scientific Methodology.

Resumen

En este trabajo se presentan los resultados de una investigación educativa realizada para la enseñanza y el aprendizaje de los conceptos clave del tema de Calor con estudiantes de bachillerato. El objetivo fue poner a prueba la estrategia didáctica denominada Investigación Dirigida y su eficacia para adquirir los conceptos científicos de Calor, Temperatura, Transmisión de Calor y un aprendizaje científico. La recolección de datos se realizó durante el semestre 2010-2011-A con 26 estudiantes de bachillerato de primer ciclo del Instituto de Educación Media Superior IEMS (Sistema de Educación preuniversitaria) que cursaron la asignatura de Física I. Los estudiantes se dividieron en dos grupos, el primero fungió como grupo experimental, donde se aplicó la investigación dirigida y el segundo como grupo de control, en el cual al profesor que dirigió esta parte de los estudiantes se le pidió desarrollar el curso de una manera tradicional. Esta investigación fue evaluada mediante un test aplicado antes y después de desarrollar el tema mencionado con la estrategia didáctica. El test es una adaptación de un instrumento de evaluación aprobado en una investigación educativa de Silveira y Moreira para detectar errores conceptuales en el tema propuesto.

Palabras clave: Aprendizaje de transmisión de calor, Investigación Dirigida y Metodología Científica.

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I. INTRODUCTION

The proposal and development of this work arise from considering a problem within the teaching of Physics, in two aspects: The first, the didactic part, which concerns to the professor, since Physics courses, generally, are imparted without giving the student an active role and with knowledge and concepts unlinked of his/her environment, making the teaching and learning of this subject lose its essence and significance. The second, the discipline part, has to do with the student; since it is observed recurrently that even with the education, the student does not use precisely the concepts of a studied theme when explaining or arguing a Physic problem or situation. Particularly within the Heat topic, although of the daily generalized interaction of people with thermal phenomena.

To support the quality of the student training and his/her academic advance we consider appropriate to work with a

didactic which motivates the scientific learning of the theme. To accomplish this we found adequate the Directed Research, of which Daniel Gil Pérez is one of the most known exponents. Next we enunciate the main questions that orientated this Research:

- Is it possible to make evolve students' previous ideas about Heat, Temperature and Heat Transmission into scientific ideas with the application of the Directed Research?
- Is there any significant difference of learning between students who learn Heat, Temperature and Heat Transmission basic concepts through Directed Research, and those who learn with a traditional training?

The corresponding Hypotheses are:

- The Directed Research favours in the student a significant evolution from the previous ideas with which he/she started the study of Heat, Temperature and Heat transmission to a scientific perspective of those same ideas.
- The Directed Research favours a better learning of the scientific conceptions within the topics of Heat, Temperature and Heat Transmission than a traditional teaching-learning process.

II. THEORICAL FRAME

What is the Directed Research?

According to Moltó [1], it is a didactic strategy that develops itself like an educational tasks system that resembles an investigation plan with a specific objective. The students' work is organized in small groups to confront their ideas. The professor has the role of director and provider of the student's learning.

Which are its advantages?

Gil Pérez [2] proposes a set of suggestions that gives/supposes the model to introduce the problem's solution without numerical data as investigation, which we enumerate

I. Pose problematic situations and consider which could be the interest in them.
II. Begin with a qualitative study of the situation that will be solved and define precisely the problem.
III. Founded with base on previous knowledge, express hypotheses about the result that will be obtained or the explanation of the studied situation.
IV. Make possible solution strategies, including the experimental ones, before proceeding with it, to avoid trial an error. Look for several solution ways, to make feasible the contrast of the obtained results.
V. Find the solution by commenting and founding what is done to avoid an operative way to solve problems lacking of physical significance.
VI. Analyze carefully the results with base on the elaborated hypotheses.

The propose to orientate the learning through the study of problematic situations is to motivate within the classroom a collective work of Directed Research that familiarizes the student with the scientific work and its results.

In this research the themes developed within the Directed Research are Heat, Temperature and Heat transmission. Their study was compatible with the proposal of the text books by Hewitt [3], Alvarenga [4], and Wilson [5].

III. METHODOLOGY

The Educational Research that is presented here followed, to its development, the methodology extracted from the books by R. Hernández *et al*. [6], and by MacMillan & Schmacher [7].

The study was realized during the 2010-2011-A semester with 26 first-cycle-high-school students from the Instituto de Educación Media Superior IEMS (pre university education System) that attended the subject of Physics I. The students were divided in two groups, the first performed the task as the experimental group, where the

Directed Research was applied and the second was the control group, and the teacher that steered this part of the students was asked to develop the course in a traditional way.

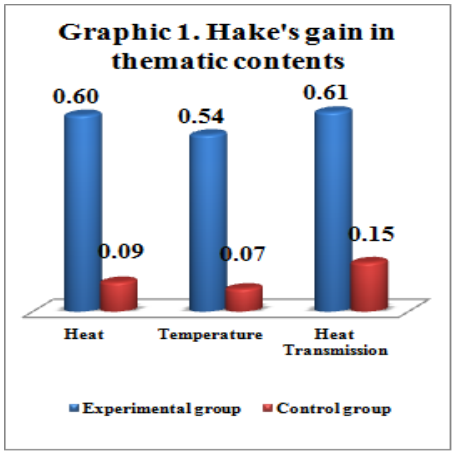
This research was evaluated by a test applied before and after developing the mentioned topic with the Directed Research. The test is an adaptation of an assessment instrument approved in Silveira & Moreira's [8] educational research to detect conceptual mistakes in the proposed theme.

IV. RESULTS AND ANALYSIS

The results analysis of the educational research was centered in two aspects:

- Contrast the conceptual advance achieved by both, the experimental group and control group, through the calculation of the Hake's *normalized gain* [9] for the thematic content.
- Contrast the investigation hypotheses, to accomplish this point, it was calculated the significance level through the t of Student [10] for thematic content.

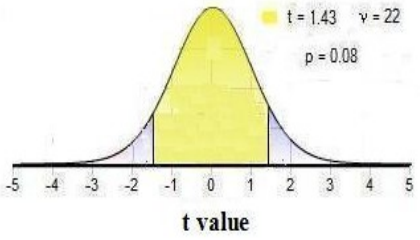
Next are shown the graphics corresponding to the Hake's gain **g**.



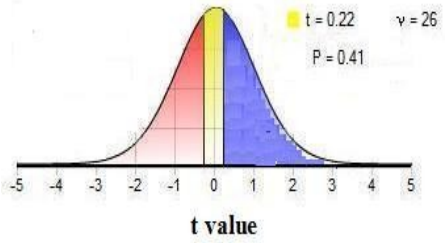
In Graphic 1 it is observed that in the experimental group the achieved gain, according to the categories established by Hake (1998), was middle for the three thematic contents. In the control was obtained a low gain in the three thematic contents.

The t of Student for the data and the significance level are represented from the Graphic 2 to the Graphic 7, which were associated in pairs to contrast the results obtained by each group and in each thematic content.

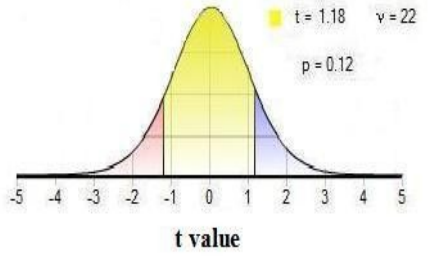
Graphic 2. Distribution of the t of Student in ***Heat*** topic for the experimental group.



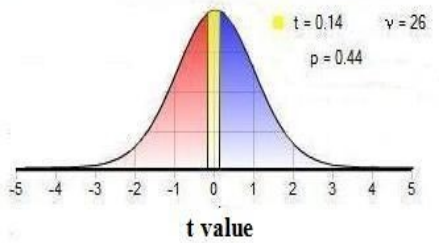
Graphic 3. Distribution of the t of Student in ***Heat*** topic for the control group.



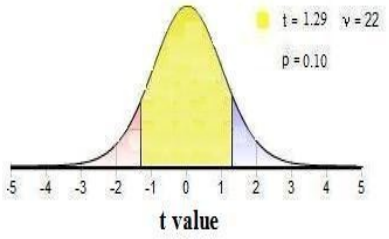
Graphic 4. Distribution of the t of Student in ***Temperature*** topic for the experimental group.



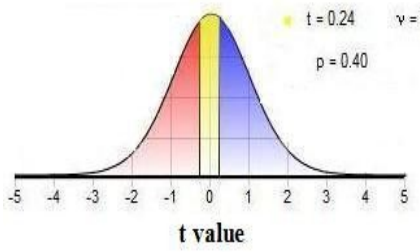
Graphic 5. Distribution of the t of Student in ***Temperature*** topic for the control group.



Graphic 6. Distribution of the t of Student in ***Heat transmission*** topic for the experimental group.



Graphic 7. Distribution of the t of Student in ***Heat transmission*** topic for the control group.



The values of the significance level that we get for the topics of Heat, Temperature and Heat Transmission in the experimental group were 0.08, 0.12 and 0.10 and for the control group these are 0.42, 0.44 y 0.40. These data helped to make the contrast of the hypotheses, since it represents the probability that the discrepancy between the measurement values obtained in the pretest and the postest could occur at random.

V. CONCLUSIONS

With base in the results, our most relevant conclusions are:

- In Heat, Temperature and Heat Transmission topics, the experimental group showed a significant difference between the conceptual knowledge acquired with the application of the Directed Research, with regard to the conceptual knowledge with which these students began. This significant difference was not observed in the control group where the students took a traditional training in the mentioned themes.
- The experimental group showed a wider conceptual knowledge of the Heat, Temperature and Heat Transmission topics acquired with the application of the Directed Research in relation to the conceptual knowledge of the control group students' with a traditional training.
- The Directed Research is a good method for the teaching of Heat, Temperature and Heat Transmission themes due to the fact that it helps in the construction and comprehension of Physics concepts starting from proposed problems and helps to the development of student's capability to express orally explanations and arguments of Physics problems treated in the school context as well as in the daily life. For that, we believe that it is worth to keep exploring this Didactic strategy in other areas of the Physics.

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