

The effects of the application of cognitive strategies for problem solving and the implementation of Gowin's V in electric field point charges



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Abstract

The purpose of this study was to determine the effects that the application of a cognitive strategy of problem solving and the utilization of Gowin's V would have on the performance of students in electric field point charges. For this purpose we used a sample of 156 university students enrolled in an introductory Physics course who were studying engineering and who comprised four groups. The students were given strategies for solving problems, Gowin's V, and traditional class instruction, however all groups received the same content. The students in the four groups took an entrance test, an exit test, and a knowledge test applying the strategies for problem solving. Later they used Gowin's V oriented to problem solving, to assist in the instruction process on the corresponding unit. All the groups took an exit test consisting of two development problems and five multiple-choice conceptual questions. To test the research hypothesis the F ANOVA test with a significance level of 0.05 was used. This study tested the hypothesis that students who applied Gowin's V and cognitive strategies for solving problems in electric field point charges perform better academically than those students who did not apply them.

Keywords: Cognitive Strategies, Problem Solving, Significant Learning, and Gowin's V.

Resumen

El propósito de este estudio fue determinar los efectos que la aplicación de una estrategia cognitiva de resolución de problemas y la utilización de Gowin's V tendría en el desempeño de los estudiantes en campo eléctrico de cargas puntuales. Para este fin se utilizó una muestra de 156 estudiantes universitarios matriculados en un curso de introducción a la Física que estaban estudiando ingeniería y que comprende cuatro grupos. Los estudiantes recibieron las estrategias para resolver problemas, Gowin's V, y la enseñanza tradicional de la clase, sin embargo todos los grupos recibieron el mismo contenido. Los alumnos de los cuatro grupos tomaron una prueba de acceso, una prueba de salida, y un examen de conocimientos para la aplicación de las estrategias de resolución de problemas. Luego usaron Gowin's V orientada a la resolución de problemas, para ayudar en el proceso de instrucción en la unidad correspondiente. Todos los grupos tomaron una prueba de salida la cual consta de dos problemas de desarrollo y cinco preguntas de opción múltiple conceptual. Para probar la hipótesis de investigación la prueba F ANOVA con un nivel de significancia de 0.05 fue utilizado. Este estudio probó la hipótesis que los estudiantes aplicaron la V de Gowin y estrategias cognitivas para resolver problemas de campo eléctrico de cargas puntuales, alcanzaron mejor rendimiento académico que los estudiantes que no las aplicaron.

Palabras clave: Estrategias cognitivas, Resolución de problemas, Aprendizaje significativo y Gowin's V.

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I. INTRODUCTION

The passing rate in the introductory Physics course in an ecuadorian university for level Zero A was 27.3%, and for level Zero B it was 46.7%. The causes of these low passing rate percentages are that the students lack strategies to solve problems in Physics, due to the fact that they memorize the formulas and the algorithms to solve the problems, they have preconceptions, and their knowledge of Physics is not

interconnected. When the students solve problems the rare use of problem solving strategies and interrelation of content are evident. They also show preconceptions when solving the problems. The students present superficial knowledge even though some manage to solve the problems, and therefore they do not have a deep understanding of the Physics concepts used in problem solving. As a result students concentrate on the signs and not on the meanings [1].

Therefore the students do not achieve a deep level of learning and the acquired learning is not significant. This makes problem solving less effective and consequently academic performance is affected, becoming evident when the student takes an exam in Physics. This problem is important in the educational context because it affects the academic performance of students, and therefore it is necessary to teach students cognitive strategies of problem solving and not just content knowledge [2].

A. Gowin’s V.

Gowin’s V is a teaching and learning tool with which the student learns in a way that makes his knowledge more profound. He answers a focus question posed in the instruction within the conceptual and methodological frameworks with which students interrelate concepts and assume a position that is discriminating, progressive and inclusive, thereby reaching a level of significant learning [3].

B. Strategies for Problem Solving

Cognitive strategies for problem solving are behaviors or internal mental processes that are revealed when an individual is faced with a problem to be solved [4, 5, 6]. Based on the literature on certain currents that investigate strategies for problem solving and models proposed by researchers who have dedicated themselves to this topic {we can cite: [7, 8, 9, 10, 11, 12, 13, 16]}, a strategy has been designed to solve problems in electric field particles.

C. Study Objectives

The objectives of this study are: Develop a cognitive strategy for problem solving to improve academic performance in students.

Develop Gowin’s V as an integration and conceptualization tool oriented to problem solving to improve academic performance in students.

Compare the effectiveness of the application of cognitive strategies of problem solving and the use of Gowin’s V in student performance.

D. Formation of Hypothesis

H1: Those students who apply cognitive strategies for problem solving in an electric field for a system of point charges perform better than those who do not apply them.

H2: Those students who use Gowin’s V for solving problems in an electric field for a system of point charges perform better than those students who do not use it.

H3: Those students who apply the cognitive strategies for problem solving in electric field particles and Gowin’s V perform better than those who do not receive this educational training.

II. MATERIALS AND METHODS

This research was carried out with university students majoring in Engineering enrolled in an introductory Physics course that includes the study of an electric field system of point charges. This research will have four intact study groups. The study took place in the room assigned for this course and lasted eight hours. The electric field instructional unit was used, to which eight hours were dedicated, as were other materials such as entrance and exit tests, the strategies of problem solving, Gowin’s V, and at the end of the unit a knowledge test was administered to measure the performance of the students.

III. RESULTS

TABLE I. Standard gain.

	entrance test	exit test	gain
Group Z	0.31	0.71	0.58
Group W	0.25	0.66	0.54
Group Y	0.39	0.59	0.32
Group X	0.45	0.59	0.25

TABLE II. Results of the F Anova analysis.

Results of the F Anova analysis		
Tools	F	P
Gowin’s V	20.89	0.0001
Strategies of problem solving	4.79	0.0302
Strategies of problem solving x Gowin’s V	0	ns

TABLE III. Performance on the knowledge test.

Group	Z	W	Y	X
Average	11.51	8.55	10.10	7.10
Standard deviation	3.7	4.3	4.5	4.1

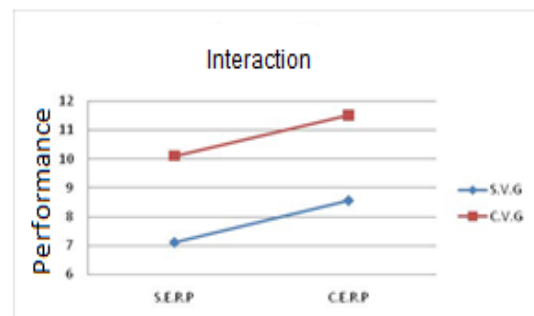


FIGURE 1. Interaction of the variables.

IV. DISCUSSION

A. Analysis of the Hypothesis

Analysis of the acceptance or rejection of the research hypothesis was conducted with the results of the F ANOVA test according to Table III.

A.1. Analysis of Hypothesis H1

This hypothesis H1 was fulfilled at a significance level of less than 0.01 and this is due to the fact that the students in group W who applied the strategies for problem solving developed cognitive skills that became evident when they solved problems. In addition they also developed algorithms such as internal mental processes which helped them solve the problems.

A.2. Analysis of Hypothesis H2

The hypothesis that those students in group Y who applied Gowin's V to solving problems was fulfilled at a significance level of 0.0302. This can be explained because the Gowin's V that was applied was oriented to problem solving, therefore the students developed the ability to conceptualize and they achieved significant learning which allowed them to solve the problems posed to them.

A.3. Analysis of Hypothesis H3

The hypothesis that those students in group Z who applied both the cognitive strategies and Gowin's V to solving problems would obtain a good performance was not significant. Therefore the null hypothesis is accepted and the research hypothesis is rejected.

In relation to Tables I, II, III, and Fig. 1, it can be said that one of the most important results of this research is that it proved that the application of problem solving strategies improved the academic performance of the students, as did the application of Gowin's V, but that the application of both tools simultaneously did not produce a significant gain in performance due to the study demonstrating that a null interaction exists between the application of the strategies for solving problems and Gowin's V.

V. CONCLUSIONS

In relation to the results shown in Table III the following comments can be made.

With regard to the cognitive strategies for problem solving and Gowin's V it can be said that group Z who applied this methodology obtained a mean in its performance that corresponds to the highest average of the scores of all the study groups.

With respect to the application of the cognitive strategies for problem solving it can be said that group W who employed this methodology obtained a mean in its performance that corresponds to the third highest average

of the groups. The application of these tools significantly improved performance compared with those who did not apply any tool. The students in this group acquired skills for problem solving which they demonstrated when taking the knowledge test, where they took an orderly approach to solve the problems. The students in this group showed a significant improvement in solving problems of development in a conceptual framework and their ability to solve problems improved.

Group Y who applied Gowin's V achieved a good performance that corresponds to the second best average with a significant difference compared with the control group. This is because Gowin's V did its work of interconnecting knowledge, which resulted in the students in this group achieving significant learning and acquiring problem solving skills because Gowin's V was oriented to solving problems.

Cognitive strategies of problem solving and Gowin's V have proven to be some teaching and learning tools that students have been able to use successfully to improve their academic performance [14].

The professors have succeeded in having their students adopt a strategy to solve problems and make relations between the conceptual domain relating concepts, laws, principles, theory and the methodological domain that has to do with records, transformations and assertions, making knowledge significant [15].

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