E-learning Metacognition in the Design and Analysis of Computational Algorithms in the ESIME-Cu in the IPN in Mexico

Beatriz Dolores Guardián Soto, Abel Camacho Galván, De la Cruz Téllez Arturo and José Juan Venta Calvillo

***Abstract*—** This paper describes the results obtained during the teaching experience in the classroom to implement in the e-learning with Gowin´s UVE and MMCC and tools derived from the theory of meaningful learning of Ausubel, Novak and Gowin, the resolution of problems related subjects analysis and design of computer algorithms used to support students in their learning. Computational problem solving is a complex intellectual process, which should not overlook the various actions taken by our intelligence to solve, this solution should be available to the level of cognitive development and abilities of the group students, should propose simple problems to develop complex skills, these problems should reflect everyday life. For the PRC by the student, greatly influences the degree of complexity of the problem and the interest in solving it, his creativity, and his ability.

The effectiveness of the algorithm is not validated by simulating the solution, you have to make use of mathematical formulas that formally prove it by induction either mathematically or as suggested by Knuth (1977), through finite method of calculation. The origin of meaningful learning grew out of interest and explains the conditions and properties of learning, stable cognitive changes, individual and social significance to solve problems such as: nature of the acquisition and retention of organized knowledge, learning skills development and resolution problems (Ausubel, 1976).

***Keywords*—** metacognition, problem solving, Gowin'sUVE, meaningful learning, e-learning.

I. Introduction

Learning theory of Ausubel (1978), appears to be consistent with the thrust of the Novak epistemology that takes into account in their research relevant to learning theory, as Ausubel presents a cognitive learning theory led to human learning and the

reality that exists in schools, in the position of the classroom. Novak and Gowin (1984a) Ausubel match that learning is a significant addition of new concepts in a non-arbitrary and substantive in the cognitive structure of students.

To Moreira (2000: p. 10), "is a process through which relates the same information on a non-arbitrary and substantive (not literally) with a significant aspect of the cognitive structure of the individual." Two tools have been developed by Novak and Gowin (1984) based on this theory, Gowin's Vee and concept maps. The first work on Gowin Vee began at the University of Cornell, USA (Cardemone, 1975, Bogden, 1977; Moreira, 1977), with university students. The diagram Gowin Vee is based on an epistemological study of an event, and is a simple and flexible method to help students and teachers to capture the

structure of knowledge and the way it is produced (Gowin, Alvarez, Marino, 2005). This is a V-shaped diagram, which visually represents the structure of knowledge. Gowin's proposed as a tool to be used to critically analyze a research, understand an experiment in the laboratory, a teaching addressed to promote meaningful learning and "extract or unpack" the knowledge of a form that can be used in solving problems (Costa and Moreira, 1995).

II. Methodology

It can be said that Gowin's UVE, invites both the teacher and the student, to be more precise and explicit about the role that the world gives its visions for the implementation of research requires that it be analyzed in philosophies, theories, principles / laws And the concepts that guide your work. The components on this side, therefore, require integration with the right side (Moreira, 1997). The objective of this study was the implementation of an educational model based on the theory of significant learning of Ausubel and Novak, who supported the career of the student in engineering and computing in the design and analysis of computer algorithms. In the School of Mechanical and Electrical Engineering of the Culhuacán Unit (ESIME-Cu) in computer engineering (IC), previous studies have been published such as the UVE and the MMCC are metacognitive strategies to promote meaningful learning in Data Structures and the Object Oriented Programming published by the author, the experience with these implementations was very positive and we can say that we help the students to self-regulate their rights, allowing them to monitor and evaluate the development process of the construction of algorithms so that you can Find flaws in the learning process.

The design of computational algorithms is a problem for students to learn to program, and this is the core of their career. This study became a point to help a student move from their cognitive structure to the logical organization of the way this learning and interests as teachers and students and learning in the construction of optimal computational algorithms as a solution to The problems This has been the most important

Beatriz Dolores Guardián Soto, Professor, Institut-o Politecnico Nacional, México.

Abel Camacho Galván, De la Cruz Téllez Arturo and José Juan Venta Calvillo, Institut-o Politecnico Nacional, México.

justification. The application began with the analysis of observations in the classroom, and you planted the research question and the construction of evaluation tools to validate the hypothesis, through registration and analysis. The data was obtained from the results in the analysis section. The discussion of the results was implemented within the instruments: interview, attitude and behavior, diagnostic examination and final guest opinion after the evaluation. The results of the implementation, the registration and the analysis of the data are favorable in relation to the significant learning and the academic performance of the students.

Elements of Gowin's UVE

1.- Define the problem

Make a program in which you can have a mastery of heuristic techniques such as the GVEU's UVE, in order to have a tool that helps us to reinforce or learn about new trends in a subject.

2.- Understanding the problem

The first thing we have to do is that the user understands what is in front of him, that is, what does the program do? What can the user do or what does the program do? As this is understood, we can worry about what the program has to do; that in this case enter data to the fields that are requested during the program

3.- General Algorithm

The main algorithm uses several actions or techniques, such as a small database, in which we must store the main concepts that our "V" of Gowin will carry. In addition to that we must take into account that there is to distribute well those concepts, that is to say, the graphical interface of exit.

1. Ask the user for the concepts
2. Save those concepts
3. Draw a "V"
4. Deploy the concepts in the "V"
5. End

4.-General Refinements

Second Refining

As we can see, it is not enough. This algorithm satisfies basic needs but does not meet expectations. Other points that we must take into account is the type of concept that will be, that is, to which part of the "v" belongs [Theory, questions or algorithm]. Also indicate how many concepts the user will have to enter.

1. Ask the user for the concepts from the theory
2. Save those concepts
3. Ask the user for the concepts from the questions
4. Save those concepts
5. Ask the user for the concepts from the algorithm
6. Draw a "V"
7. Deploy the concepts in the "V"
8. End

Third Refining

Now we must become aware that the limit for which it will be programmed [C ++ using Graphics.] On the screen, ie its dimensions. We must reserve the space so only 5 concepts per section will be used.

1. Ask the user for the concepts from the theory (5max)
2. Save those concepts
3. Ask the user for the concepts from the questions (3max)
4. Save those concepts
5. Ask the user for the concepts from the algorithm (5max)
6. Draw a "V"
7. Deploy the concepts in the "V"
8. End

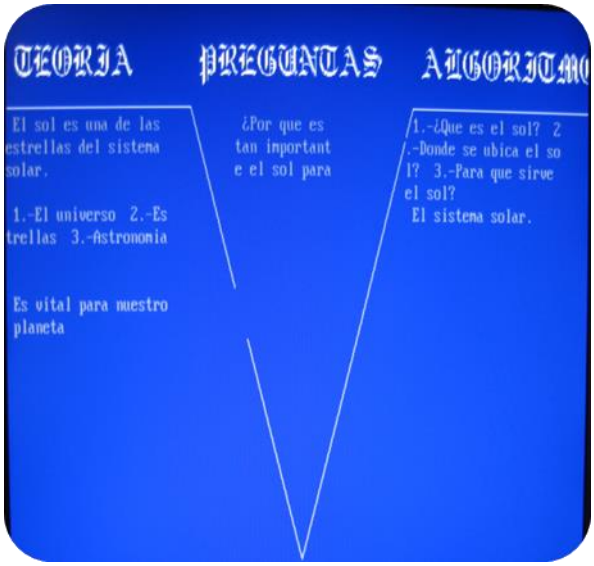


Fig. 1 Gowin´s UVE virtual

Figure 1 shows the virtual UVE for the student to use in solving the problems proposed in the construction of the algorithms.

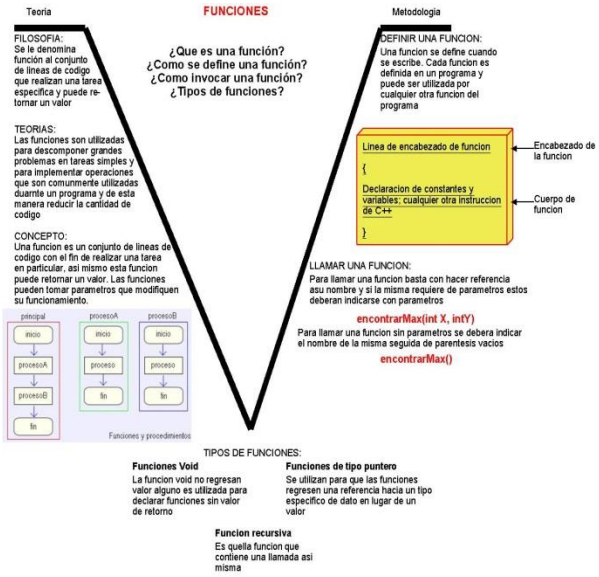


Fig. 2 Gowin´s UVE

Figure 2 shows an example of the virtual UVE applied by the student in solving the problems of algorithms of functions or methods.

The methodology was carried out in four stages, stage 1 was the preparation of material for the course construction of evaluation tools, planning of search methods and document analysis for the solution of the proposed problems in order to achieve significant learning of the design and analysis of the algorithms, this stage was done both physically and virtually,

using the internet and electronic databases, to know at least most of the documentary sources related to the research topic, the software of cmaptools, was of great support in the construction of the maps for the planning of this task, as well as to build the database of the documents found, in the selection and review and analysis of the most important documents.

In Phase II Application of the Questionnaire and Disgnostic Exam.

In phase III, the implementation of metacognitive strategies was carried out; UVE of Gowin and the conceptual maps of the following form:

At the beginning of the semester a survey was applied to the students, which was integrated by a test of knowledge, one of attitude and behavior, to know the student, their social environment, the academic environment, study methods, motivation, attitudes , skills and abilities in problem solving, etc.

From the registry of the obtained data, it was possible to design the virtual didactic material which was developed with the metacognitive strategies of the Gowin's UVE and the conceptual maps for the student. The same was done for the electronic laboratory manual and other materials and formats to carry out the course.

On the second day of classes, teams of no more than three

students were formed, explaining the reason for the grouping, the importance of the collaboration and integration of all the elements of the team, the importance of the distribution and participation in the tasks, since they would work together the semester and it was important their participation in the solution of problems proposed in class, the exhibition of them and their suggestions, criticisms and contributions during class activities.

III. Results

From the results, we conclude that the use of Gowin's UVE improves the dialogue between the teacher, the student and the educational materials, thanks to Novak with his theory of education, positive results were achieved in both departmental evaluations as in the conceptual advance and the practical application and through interactive virtual material.

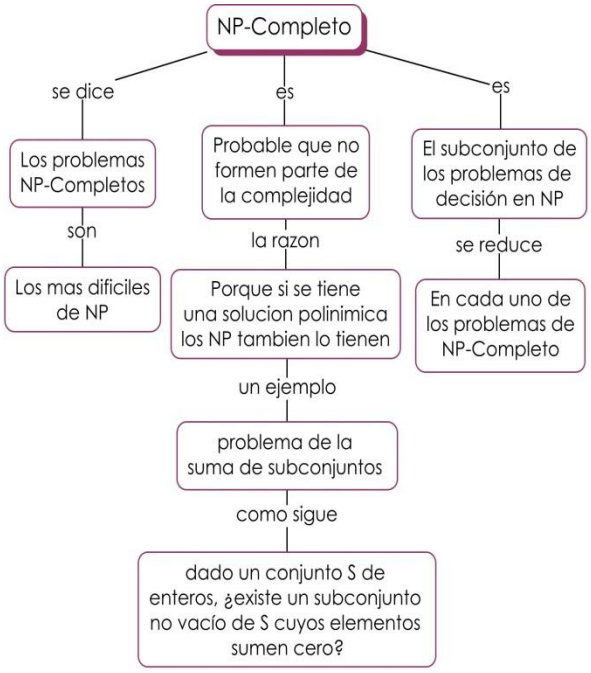


Fig. 3 Map Problems NP

Figure 3, 4, 5 and 6 show an example of a conceptual map constructed by the students of the subject.

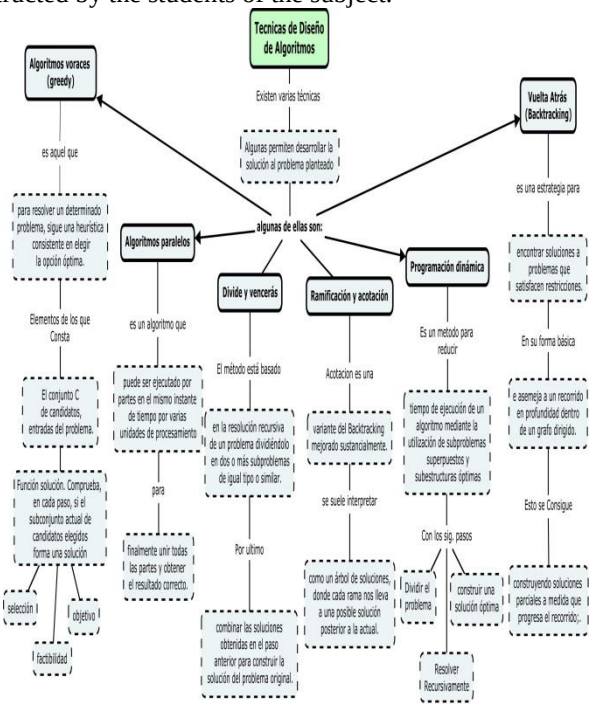


Fig. 4 Map of the Design and Analysis of Algorithms

Figure 4 shows a map of the algorithmic complexity, notation of the large O and other notations.

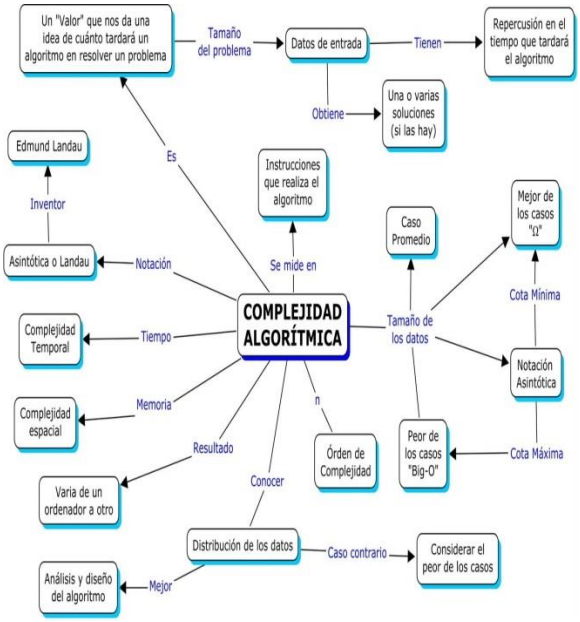
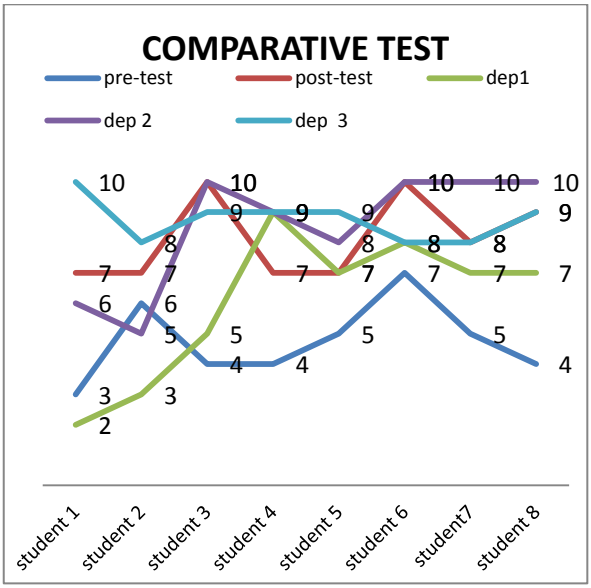


Fig 5. Map Algorithmic Complexity

Based on the analysis of the results of the interviews and the attitude and behavior tests, as well as on the knowledge tests applied before and after the course, evidence of the students' attitudes and opinions on the content material of the course, can conclude that: There is evidence that if the students have achieved significant learning, we can say because they met the three conditions necessary to achieve meaningful learning. In this research, the group that was taught under the proposed model is able to integrate theory and practice through Gowin's UVE; This enrichment was not only methodological or purely theoretical, but it allowed us to draw conclusions from the daily teaching practice as shown in graphs 1 and 2.

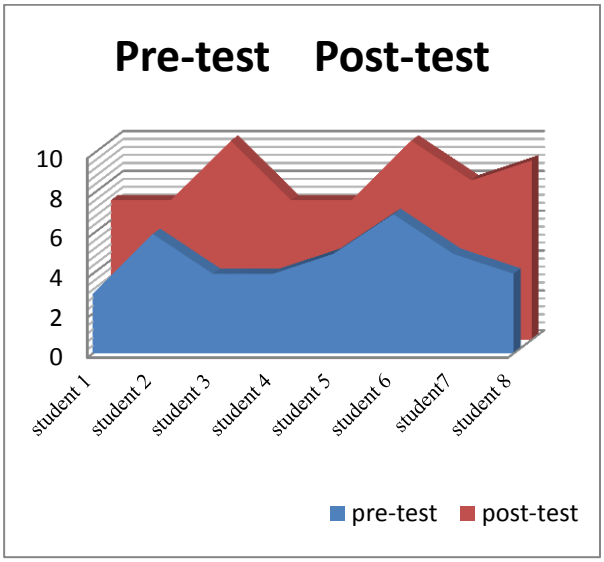


Grafica 1. Comparative test

Graph 1 shows the results of the sample taken from a group of 24 students, were chosen at random.

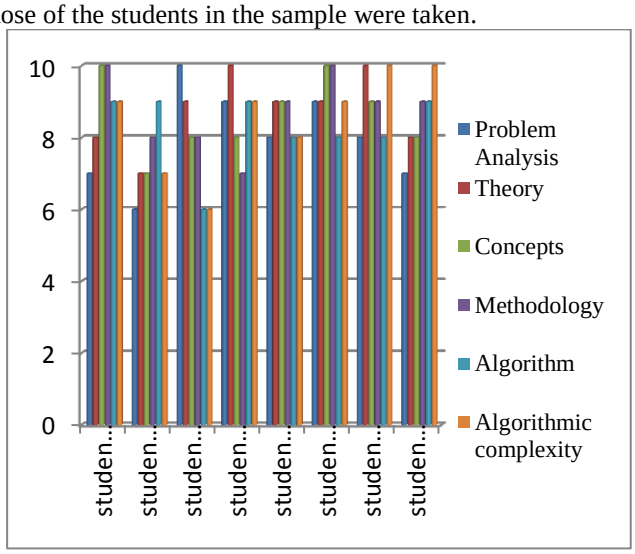
Although the metacognitive strategies were applied by the whole group, for statistical purposes only a sample was taken.

Graph 2 shows the results obtained when applying an exam at the beginning of the course and the exam applied at the end of the course, as can be seen there is a favorable result, a better use of the students of the computer engineering career in the subject of analysis of algorithms.



Graph. 2 Analysis Pre y Post test

The Graph 3 shows the results of the evaluation of the EVUs constructed by the students. A UVE was built for each problem proposed in the laboratory as well as in the problems in the classroom. The UVEs constructed by the students were evaluated in their entirety, however for statistical purposes only those of the students in the sample were taken.



Graph 3 Evaluating Gowin´s UVE

IV. Conclusion

The response was successful. It can also be affirmed that according to the results, there is an improvement in the quality of the significant learning indicators in the students that are implemented in the Gowins UVE under the theory of Ausubel, Novak and Gowin in the design of algorithms. We measure the incremental progress of the student through a qualitative

analysis of Gowin's UVE, constructed by the students for 16 laboratory practices, as in the problems of the theory class, for those who use the log table for the analysis of each. Of the elements of the UVE, these elements describe them in the methodology. The conceptual maps and ECPM are used in the diagnostic test and the post-evaluation as qualitative tools to study the circulation of the cognitive structure of the student, they should be the ones that the students will know about the background they should be for assimilating and learning the new content according to object-oriented progress, to the goal that is completed with success, to agreement with the results, as well as through the means and the standard deviation. The above represents an improvement in the relationship with academic performance among students and what was implemented in V of the theory of Ausubel, Novak and Gowin in the design of Gowin algorithms. It is concluded that Metacognition e-learning becomes a significant progress in the experimental group with respect to significant learning and academic performance.

REFERENCES

[1] González, F. M.El Mapa Conceptual y el Diagrama V. Recursos para la Enseñanza del Siglo XXI. Madrid: Narcea, 2008.

[2] Guardian, B. Estrategias para fomentar el aprendizaje significativo de la Asignatura de Análisis de Algoritmos en el nivel de E. S., ESIME-Cu, IPN, Unpublished Ph. D. thesis (IPN), 2003.

[3] Guardian, B. CEGA, Memorias del XX Simposio Internacional de Computación en la Educación, México, 2004.

[4] Guardian, B. El laboratorio virtual en la asignatura de Graficación a través del MELGA, un material didáctico interactivo como estrategia docente en la asignatura de Graficación. Memorias del XXI, 2005.

[5] Guardián, B. La Teoría de Ausubel, Novak y Gowin en la enseñanza del DAC. El uso de la V de Gowin. Unpublished Ph. D. thesis (Universidad autónoma Metropolitana de Xochimilco, Depto. de Ciencias Sociales, Área de Educación y Sociedad, México), 2009.

[6] Novak, J.D. and Gowin, D.B. Learning How to Learn. Cambridge and NY: Cambridge University Press, 1994.

[7] Moreira, M. A. Diez años de enseñanza de la ciencias: de una ilusión a una realidad. Enseñanza de la Ciencias, Barcelona, España, 12(2): 149-153, 1993.