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THE USE OF CONCEPTUAL MAPS IN TECHNOLOGICAL SUBJECTS OF THE CAREER ENGINEERING IN COMPUTER SYSTEMS

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Abstract — *In this communication are summarized the experiences that have been executing from 2004 with students that take subjects of technological content guided to communications and hardware. The objective is focused on the application of the techniques for elaboration of conceptual maps as one of the possible learning tools. Its use in the technological field, allows the students to travel and interpret all the conceptual contents. It is seek that they can find the significant connections in order to be able to visualize the conceptual net of the topic approached for each chapter of the program. It is observed that the form doesn't have study antecedents in the students of technological subjects. To carry out this assignment it is requested the formal presentation of a printed and digital work that includes the whole material worked by each thematic unit using the maps.*

Index Terms — *conceptual maps, meaningful learning, technological subjects*

INTRODUCTION

In this communication are summarized the experiences that have been executing from 2004 with students that take subjects of technological content guided to communications and hardware. The objective is focused on the application of the techniques for elaboration of conceptual maps as one of the possible learning tools. Its use in the technological field, allows the students to travel and interpret all the conceptual contents. It is seek that they can find the significant connections in order to be able to visualize the conceptual net of the topic approached for each chapter of the program. It is observed that the form doesn't have study antecedents in the students of technological subjects.

From the use of the study tools, taking the suitable bibliography for the subject as a starting point, the students should find the significant connections of the conceptual plot relating the thematic group corresponding to the different contents of each key of the subject. To carry out this task, rythe formal delive of a printed and digital work that includes the whole material worked by each thematic unit, are requested. The tools allow establishing the hierarchization of levels in the concepts and the plot of the connections among them.

THEORETICAL FRAMEWORK

A conceptual map is a creative process that is carried out in a gradual way. When working in groups, it could be executed through a process of negotiation of meanings among the members of the group that could give rise to modifications and reacommodations of the map. The creation of the map starting from a group of concepts can be understanded through the Ausubel's theory of the significant learning *et al.*, (1987) [1] and theconstructivist theory that explains how the learning takes place [2].

The conceptual maps were created in the 70's by Novak, who analyzed their use with the collaboration of Gowin [3], taking the theories of the significant learning as a starting point. They arise as a basic tool to represent the significant relations among concepts through classified and related information. They allow presenting significant relations among concepts in the form of propositions where the relations are stated by means of lines and arrows that highlight the premises, similarities and differences between the concepts and their hierarchical organization. *A conceptual map is a schematic representation of a group of conceptual meanings included in the form of structures of propositions.*

Exist several ways of preparing a conceptual map, that is to say different ways of showing how a group of concepts can be related in diagram form. Thus, the conceptual maps prepared by different people about the same topic can have differences as for the relation of the involved concepts and to the connecting words that each one

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uses. Each map is a reflection of each student's cognitive structure and the negotiation of maps and meanings allows increasing this structure.

The learning contents should be ordered in such a way that the most general and inclusive concepts show up at the beginning to favour the formation of concepts in the cognitive structure. This is achieved through the *progressive differentiation* and the *integrative reconciliation* that allow organizing the content of the subjects. The *progressive differentiation* consists on presenting the most general ideas in the topic first, continuing with a gradual increment of details and specificity. The *integrative reconciliation* means that the new concepts should be related with the learned content. For this reason, the didactic sequence should be organized so that each consecutive learning is related with the previous ideas [1].

"The significant learning, is a globalized learning insofar as the new learning material can relate in a fundamental and no arbitrary way with what the student already knows", [4], with quality of that learned and duration of the storage.

The *concepts* are words that provoke a mental associated image when evoking it. Even though the meaning of a word is known, everyone can imagine the same thing although with some differences. In the map other words are used that are the *link* words and these are used when speaking or writing. Among these words, the can be mentioned: *it can be, it is, then, they serve, it implies, etc.* The link words are used together with the concepts to form sentences with meaning, which is to say to form a *proposition* [2].

In each bond, link words that allow having an explicit relation among concepts are indicated. In each conceptual map the central idea is defined in the center of the diagram and the relations among ideas are established in an easier way. For their elaboration, the outstanding concepts should be identified and selected, then a hierarchy should be established among the same ones in order to be able to distinguish the generals from the most particular ones.

These actions are linked with the progressive differentiation of the knowledge that Ausubel proposes [1] and the subsequent *"integrative reconciliation"*, hence the learning sequences have to be ordered starting from the most general concepts and to go advancing in a progressive way toward the most specific concepts.

DEVELOPMENT

Para elaborar un mapa conceptual hay que tener en cuenta los siguientes pasos: *a) Seleccionar un tema, b) Armar una lista de conceptos importantes, c) Ordenar los conceptos desde los más generales a los específicos, c) Construir el mapa con los conceptos generales en la parte superior bajando hacia los específicos en la inferior, d) Unir los conceptos mediante conexiones que deben contener palabras de enlace, e) Establecer enlaces significativos entre las diferentes jerarquías del mapa.*

To elaborate a conceptual map it is necessary to keep in mind the following steps: to) To select a topic, b) To organize a list of important concepts, c) To order the concepts from the most general to the specific ones, c) To build the map with the general concepts in the superior part lowering toward the specific ones in the inferior part, d) To join the concepts by means of connections that should contain link words, e) To establish significant links among the different hierarchies of the map.

The most common form is the use of a type of conceptual map in which the most general and inclusive concepts appear in the superior part of the map. Continuing from top to bottom in the vertical sense, other concepts appear in descending order of inclusiveness arriving to the foot of the map with the most specific concepts and the examples if there were any (to see Figure 1).

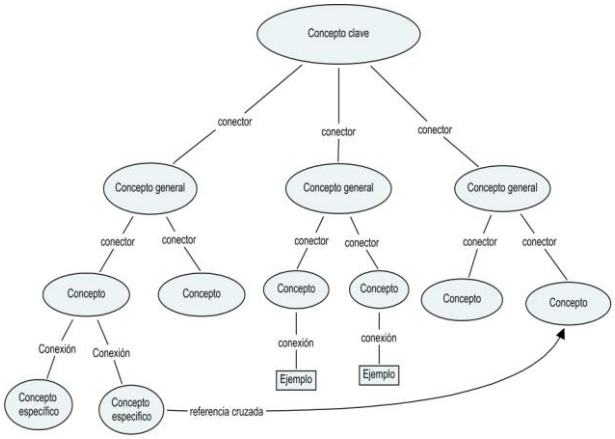

Figure 1**:** How a conceptual map is.

The reading of the map should begin with the concept of more hierarchy that is to say that which is at a greater height with regard to the other ones, and the reading sequence should be carried out by means of the pursuit of the lines that originates from the main concept or from the one of more hierarchy.

The significant learning requires three basic conditions that are: to) The material that is going to be learned should be conceptually clear and presented with a language and examples that can be related to the apprentice's previous knowledge, b) The apprentice should have previous outstanding knowledge and c) The apprentice should choose to learn significantly [5,6,7].

The experiences: The subjects where the experiences were performed were: Technology of Computers, Teleinformatics and Communications, whose profile is of highly technological contents oriented to the communications and the hardware.

The objectives looked for in the development works were: a) Constant presentation of homework for each unit of work in order to be able to guarantee and to allow a continuous pursuit of the student's learning during the subject academic period, and at the same time, forces him to maintain a continuity in the study to be up to date with the worked contents. It is looked for minimizing the discontinuities in the learning process and it is considered essential in the continuity of the study for the students. b) It is looked for applying the technique of the conceptual maps (although they can opt to do hierarchical summaries as tools for the learning) and that they see themselves necessarily forced to scan and to interpret all the conceptual contents and to establish the connections with them in order to visualize the conceptual net of the topic approached in the unit. As the classes go by, this allows them to interpret the cognitive linking of the conceptual plot of the thematic nucleus. c) Finally, they are requested the formal presentation of the work (printed in a folder and a CD containing the files of the whole given in material).

The **final objective** is that the students can self-evaluate what they have learned through the homework with the use of the maps before taking the mid-term exam. To do this, two moments are important: a) first: when studying for the mid-term exam, it improves the understanding of the concepts and their framework; b) second: they can be used as a support for the self evaluation and to see the weak points before taking the exam.

The presentation of homework, is fixed according to three considered categories: a) *In advance* (7 days after the teacher has concluded the subject), b) In term: (14 days, after the subject was concluded), c) Late: 2 weeks later. Also, the given material is evaluated; the continuity of the presentations in order to guarantee the continuity of the study is very much motivated and considered.

The requested work should be carried out in groups from 3 to 6 people according to the size of the courses and the activity is executed according to the main thematic content of the subject's program, coincident with its corresponding bibliographical chapter.

The allowed category for the elaboration of the work can be pure, of conceptual map or another traditional method as the hierarchical summaries or a mixture of both. The student is allowed to choose the more appropriate option in order to facilitate his/her learning. The convenient graphic images can be incorporated with the corresponding references. Therefore that without stopping to see the quality of the work, it is motivated and considered the continuity and the fact of being up to date with the presentations in order to guarantee the continuity of the study. At the end of each work, they are also asked to carry out an integration activity to report of a suitable appropriation of the concepts.

The given material is evaluated by its observance as much in time as in form and a credit is granted by excellent work, executing this way the formative evaluation that together with the subject's summative evaluation complete the activity of the college student during the period of the attended subject.

The **final integration activity**: Finally they are asked to carry out an integration activity as a form of verifying the conceptualization by means of the generation of a crossword of the most important chapter's concepts (typically it is requested 20 questions at least). It is presupposed that once identified the concepts' key/s word/s, the integration activity is to be able to formulate the correct question that guarantees a suitable answer in the crossword grid (that is to say that there is also an individual verification in the activity). Software free is used to generate the typical grid in an easy form.

RESULTS

The information given by students of the last five years allows obtaining some conclusions. The experience indicates that the activity in terms of conceptual maps is complex because it is applied to technological subjects where there is no tradition in its use and it is observed that who uses them take advantage of the effort since he/she understands the linking of the integrated contents strongly in the net of concepts. Although in contrast, some students manifested to have greater ease with other methods.

In the Figure 2 two maps are observed on topics the unit 1 of Technology of Computers.

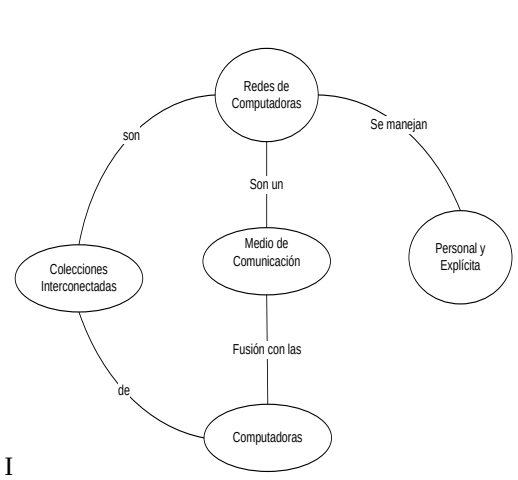

Figure 2
Map about introductory topic

Totales/ Asignatura	Total Alumnos Aprobados c/MC			Total Alumnos Aprobados s/MC			Totales Generales de Aprobados		
	Curs	Apr	%	Curs	Apr	%	Curs	Apr	%
Tecnología de Computadores	27	23	85	58	39	67	85	62	73
Teleinformática									

y Comunicaciones	16	15	94	62	44	71	78	59	75

Table 2: Approved students using maps and other techniques, and general totals of approved students in the five year period

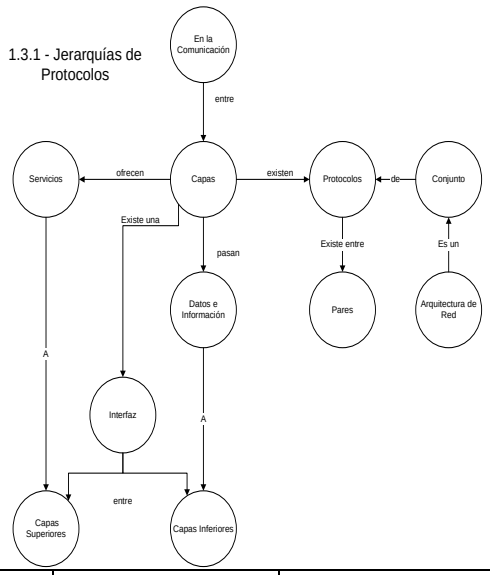

Figure 2
Map about hierarchy of protocols

In Tables 1 and 2, is observed the number of students by year that worked with the methodology of the conceptual maps and the percentages of approved ones using maps or other techniques. The data obtained during 2010 are being Processed

Starting from the analysis of the Table 1 it can be appreciated that throughout the data informed for both subjects, the percentage of approved students in both cases was bigger for those that worked with conceptual maps regarding the other ones that didn't do it (85% regarding 67% in a case and 94% versus 71% in the other one) , overcoming in both cases the percentage of the general total of the five year period.

Años/ Asignatura	2005				2006				2007				2008				2009			
	c/MC		s/MC		c/MC		s/MC		c/MC		s/MC		c/MC		s/MC		c/MC		s/MC	
	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr	Curs	Apr
Tecnología de Computadores	5	4	11	10	5	5	15	11	4	4	12	5	6	4	11	8	7	6	9	5
Teleinformática y Comunicaciones	4	4	10	9	4	4	8	4	0	0	21	13	3	3	9	7	5	4	14	11

Table 1: Students for year that worked with the methodology (References: C / MC: with Conceptual Maps, s / MC: without Conceptual Maps, Curs: Attended Subject, Apr: Approved)

CONCLUSIONS FUTURE RESEARCH FIELDS

The experience indicates that: the activity in terms of conceptual maps is complex since they are technological subjects, but it is not impossible. Those who use the conceptual maps indicate that in the moment of taking the evaluations, the effort is capitalized as understanding the plot in the net allows to have the contents visually integrated and not to have them in a dispersed form.

The subject Teleinformatics and Communications presented a bigger approval percentage for those who worked with maps and it is believed that this is due to the fact that the contents in Technology of Computers are more technological and hence they present more difficulties to the students.

It is planned to include a conceptual map corresponding to each thematic unit to have the global vision of the approached matter. Also, when beginning the classes it is planned to present the global map of the subject. This will serve as base to be able to indicate where the topic to see inside the general contents of the subject is. At this time, it can make it manually in the blackboard or it can be showed from the specific software CMap Tool (IHMC, 2007).

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