Collaborative Learning of concepts in Distance Learning
Conceptual Map: Analysis of prototypes and categorization levels

Maria Suzana Marc Amoretti[1]

Abstract

Concept learning supported by computer must take into account the features of the groupware used, but also the collective semantic universe that is formed. A virtual group of students building concepts through the Internet, in a distributed and asynchronized manner, may be recognized as belonging to a given culture through the cognitive dimension expressed by the shared conceptual maps. This research was performed with the software CMap Tools from West Florida University used by students of Distance Learning (Specialization) of Informatics in Education at UFRGS, Brazil. This research is conducted by a vibrant cognitive science team – "LEAD: Distance Learning Laboratory, Cognitive Science and Semiotics Research"[2], a newly established cognitive science research laboratory devoted to the categorization, visual perception, knowledge management, computational study of knowledge, language and action. We tried to identify *ideological similarity* and *cognitive deviation*, both based on the prototypes and on the levels of categorization developed in the maps, with an emphasis in the investigated groups cultural and semiotic aspects.

Keywords: cognitive science, semiotics, share conceptual maps, ideological similarity, categorization, share learning, distance learning.

1. From semantic networks to conceptual maps

"The notion of knowledge performs a central role in learning. What we know about beings and things are constituted under the form of concepts, which may organize in different forms. Artificial Intelligence has been using semiotic or semantic networks to represent the diverse types of knowledge for years".[3] This is the trend called connectionism, which embraces a network of connected knots whose networks entries and exits are conceived as representations (Cummins, Robert and Schwatz, and Georg[4]).

"The representation of knowledge in networks helps forward, thus, knowledge comprehension, since human memory recognizes and retains more quickly prototypic models, answering in a more satisfactory manner the readers' reality expectations, making the mental process of understanding easier. The network simulates typical aspects of human cognition, having as essential feature the flexibility in the modeling of cognitive phenomena, which is the network ability of always completing the concepts described through the association of new properties to basic concepts". [5]

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[1] Cognitive Science Professor at Federal University of Rio Grande do Sul. (UFRGS) and FEEVALE University Center, Leader of LEAD: Distance Learning Laboratory of Cognitive Science and Semiotics Research:

[2] LEAD: Distance Learning Laboratory: Cognitive Science and Semiotics Research http://www.pgie.ufrgs.br

[3] Amoretti, Maria Suzana Marc. *Representing knowledge in semantic networks*. *In The* (re) invention of teaching. A report of the differences and plural possibilities found at UFRGS teaching courses. Booklet PROGRAD, nº 14, Graduation Pro-Rectorship, Federal University of Rio Grande do Sul, 2000, p.73.

[4] Cummins, Robert e Schwarz, Georg. Connectionism, computing and cognition. *In* Andler, Daniel. Introduction to cognitive sciences. São Leopoldo: UNISINOS, translated by Maria Suzana Marc Amoretti, 1998.

[5] Amoretti, Maria Suzana Marc. *Representing knowledge in semantic networks*. *In The* (re) invention of teaching. A report of the differences and plural possibilities found at UFRGS teaching courses. Booklet PROGRAD, nº 14, Graduation Pro-Rectorship, Federal University of Rio Grande do Sul, 2000, p.74.

The work with conceptual maps has as its starting point the previous knowledge of the student on a given notion. To Novak, the concept is a regularity perceived in facts, objects, memories of past facts, and which is expressed by a label (Novak, 1998). When concepts to be learnt are not related with the previous knowledge of the student, what Ausubel calls "rote learning" takes place.

Thus, when students turn the known concepts into a graphical form of a conceptual map, relating this initial notion with others also already known, establishing a hierarchy and/or determining properties, they may organize their knowledge in an autonomous manner, adjusting their own reasoning according to the map building. This learning concept, based on Ausubel, is called "meaningful learning".

In order to perform meaningful learning, conceptual maps proved to be an appropriate tool because they allow the students (and also the professors) to develop a cognitive process of leaning in which they guide their acquisition of new information, since this information will be directly related to their previous knowledge structure. It is important to stress that "previous knowledge structure" is understood here as that one the subjects hold, at the moment of learning, as a product of their cultural integration.

This way of representing the concepts allows what we call "***properties heritage***". It is not necessary to store in the memory the group of properties relating to each concept. The inherent properties to the base concept are enough as long as the other properties relating the remaining network concepts may be inferred. It is tough, not to say impossible, to separate semantic networks presentation from the notion of ***mental scheme*** (Schanck, 2000) because schemes are used to express knowledge to understand, memorize, infer, and also represent the organization of different kinds of knowledge in memory.

2. Cooperation /Collaboration / Autonomy

Autonomy and cooperation / collaboration are not excluding or contradictory concepts. When working in teams with conceptual maps, it is important to guide the team members or the students on the learning and knowledge theory underlying conceptual maps building. The elaboration of a global map by the group from individual maps or from the building, from the start, of a collective map implies the inclusion of everyone's knowledge and the creation, as a team, of new kinds of knowledge, inherent to the group.

In this sense, the building of a map involves collaboration, when the students share information, still without modifying the data, and involves cooperation, when students not only share their knowledge, but also may interfere and modify the information received from their classmates, acting in asynchronized way to build a collective map. Both cooperation and collaboration attest the autonomy of the ongoing cognitive process, the direction given by the students themselves when trying to adequate their knowledge to their mates' knowledge.

CMap Tools, for instance, integrates the concept of hypermedia – aggregation/juxtaposition of different medias in a sole media with a sole aim – turning each map created into a hyper document, allowing navigation through the unlimited links that may be used to associate information, respecting the user's learning style. However, form the pedagogical point of view, it is not really convenient to offer a navigation with no restrictions through all the hyper document knots (conceptual map), to avoid that the student feel confuse by the cognitive overload. Besides, the possibility of the guided multimedia use to illustrate and enrich the concepts studied allows the students to take part in the teaching and learning process, determining their own way of studying, according to personal preferences foe the choice of multimedia references external to the map structure, and being able to review concepts as many times they wish, even in a simulation environment. Multimedia importance is to encourage the students to search for other attributes that will enrich and complete their initial concept, which is rather individualized. The students feel several times shy and unaware of the multitude of relation this concept could generate.

3. Research held in the LEAD: Distance Learning Education Laboratory : Cognitive Science and Semiotics at the Federal University of Rio Grande do Sul (UFRGS) diagnosing the ideological similarity through the analysis of the students' conceptual maps

By using a collaborative building software via Internet we may verify the ideological similarity among groups of students by the presence of a common knowledge expressed by the general concept and their unfoldings, by the existing correlations among the distinctive traces of the fundamental categories (the abstract ones), evidencing the maps internal cohesion and the presence of mental schemes common to a

given social group, revealing, then, the "ideological similarity" (Stich, 82-83) among some concepts, which Winograd (Winograd, 75) has denominated as "micro world" in his famous simulation program SHRDLU and which Dreyfus, later J.-P. Desclés, calls "Referential Universe".

In the Post Graduation Program of Informatics in Education at UFRGS I researched conceptual maps in *distance learning lato sensu* in the disciplines of Doctorate in which, despite the work performed during the weekly classes, there is always much to be done for the distance-learning group. This kind of environment allows a large individual participation, since the students have autonomy to freely organize their knowledge according to the semiotic outline of their collective and individual culture. At the same time, it also allows a great interaction among the students as long as this tool, especially with the innovations brought by version 2.9.1.(CMap Tools) and 3.0, which permit that each concept is discussed separately, through the resource called "soup"; this software still provides the discussion of the pertinence of whole sequences, through the resource "thread discussion".

4. Difficulties presented during the collaborative work with conceptual maps

Both the concepts and the chaining and choice of the pertinent attributes discussions are made completely at distance. When it came to interact in order to create a collective conceptual map, there were some difficulties among the students, who experienced a certain resistance to the idea of giving up their identities on behalf of a collective authorship.

In order to minimize this feeling of identity loss diluted in a superior instance – that of the group – several conventions were created. These codes established by each group aimed at facilitating the interaction among the different forms of organizing the students' knowledge. It is really interesting to observe that in groups with a weak ideological similarity or with the presence of an element to characterize the "cognitive deviation" (the word "deviation" is employed here with no value connotation), the cooperation and collaboration efforts are necessarily bigger and more complex. Professors' position, through questions that help students clearly explain what they really want to say with each notion used, will improve the chances that the group's efforts result in the creation of a consensual conceptual map.

5. Metacognition

The maps collective creation phase (in the process of distance learning) is a really delicate issue, and it involves several problems and susceptibilities, such as the authorship of a given graphical configuration. Thus, we tried to reach a previous consensus with the students and certain strategies were used to preserve the wok authorship before passing to the final phase, in which the map becomes everyone's map, with no distinctions. These strategies, defined with the group, are: the use of different colors for each user, to concede visibility to each one's contribution (authorship), the use of specific colors for links, different colors and spatial disposition for attributes and categories.

We also opted to repeatedly save the maps conceived so all the versions could be compared. This worry about the creation process memory is a very strong metacognition feature that cannot be neglected during the concepts learning.

6. Individual appraisal

Students' attitude is autonomous due to the individual appraisal of their work. The student is not evaluated by the professor. There is not a right or wrong map. There is not a size pattern for the map, or an exact number of relations among concepts to be established. Students are completely free to organize their knowledge, change their map as many times as needed till they feel it shows, in a approximate way, of course, the way they see the world.

It does not mean, however, that the map should not be evaluated, but not according to traditional methods of "right and wrong". **Maps must be defined as for the associative character (attributes) or the classificatory character (categories) prevalence** and, from this option, made by the students or suggested by the professor, their coherence will be evaluated. An excellent map is a coherent, cohesive, creative expressive, and logical map. Depending on the concept studied and on the class aim, the adjectives mentioned above will have different weights concerning the map evaluation.

7. Ideological similarity realized through prototypes and stereotypes

Ideology is always viewed as a classification, in its verbal or imagetic manifestation, in which one element, compared to others, is situated in a given semantic category. The values used in this axiology result from the semiotic articulation of the collective universe in which the subject is inserted – a subject modeled, mainly, by the actions believe, /want/, /must/ and by /want to do/.

This categorization approach that discards the myth of the computer and the maps elaboration lack of ambiguity, attempts to include the prototype presence as the most usual manner of using a given object, also questioning the strict boundaries among the categories that reflect, before anything else, the Observer's perceptive structure and the world social and physical structure. This new point of view, which has as its forerunners Ludwig Wittgenstein and Eleanor Rosh, does not realize categories as arbitrary concepts, but as concepts motivated and determined by culture, images, mental models, appearance, analogies, by the use of metaphors and other mental processes. Concepts common underlying structural properties turn them into semiotic objects performing a social and cultural role that will reveal the subject and his/her group.

Thus, from each subject's mental schemes, forged by his/her culture, concepts and, particularly, **prototypes**, are produced. In most of the cases the terms prototype and stereotype are used indifferently to designate the two levels. However, we distinguish these two realities defining **prototype** as the object that is a category best model and **stereotype** as our mental representation of this object. Prototype is defined by extension, it is a referential subcategory, while stereotype is found in the intention level and it does not correspond to the idea of "best model" common to the subjects belonging to the same community or, still, as a combination of typical properties.

A conceptual map organized in categories is necessarily supported by the idea of a prototype, obeying to the following statements:

1. Every category has a prototypical internal structure;
2. The level of representation of a model corresponds to its degree of pertinence to the category;
3. The boundaries of categories or concepts are vague;
4. The embers of a category do not present properties common to all the members. There is a "familiarity" that regroups the conjunct;
5. Belonging to a category depends on the degree of similarity with the prototype;
6. Categories operate in a global manner.

Deciding whether an element belongs to a category implies the action of verifying if the concept possesses the necessary attributes that constitute the category common denominator. In order to X belongs to the dog category, for instance, it is enough to investigate if X possesses the attributes that correspond to the ***model of necessary and sufficient conditions*** (Kleiber, 1990) or to the ***model of judicious attributes*** (Langacker, 1987), i.e., if X is an animal, a mammal, has four feet, barks, has coat, etc.

Prototypes

A concept is a sort of scheme. An effective way of representing a concept is to retain only its most important properties. This group of "most important" properties of a concept is called *prototype.* The idea of prototype makes possible that the subject has a mental construction, identifying the typical features of several categories and, when he/she finds a new object, they may compare it to the prototype they have in their memories. Thus, the prototype of "chair", for instance, allows new objects to be identified and labeled as chairs. In individual conceptual maps creation, one may confirm the presence of variables for the same concept.

Prototype semantics has given way to a true revolution (the Roschian revolution) regarding classic lexical semantics. If we observe the conceptual map for "chair", for instance, we will realize that the choice of most representative chair type, that is, our prototype of chair, supposes a double adequateness: **referential** because the sign (concept of chair) must integrate the features retained from the real or imaginary world, and structural, because the sign must be pertinent (ideological criterion) and distinctive concerning the other neighbor concepts of chair. When I say that "this object is a chair", it is supposed that I have an idea of the "chair sign", form the use of a lexical or imagetic competence coming from my referential experience and that my prototypical concept of chair is more adequate than its neighbors *bench* or *couch* because I perceive there is a back part and there are not arms. Then, it is useless trying to explain the creation of a prototype inside a language, because it is formed from context interactions. The double origin of a prototype is bound, then, to *shared knowledge* relation between the subjects and their community.

7. Suggestions to facilitate collaboration using conceptual maps software

We could realize, for sure, that the essential importance and interest of these structures – prototype and stereotype – may represent knowledge under the form of hyperonimy relations that make us infer new relations through logical base mechanisms. This general principle of representing kinds of

knowledge grounds the prototype and stereotype notions and may be developed in several formalisms; one of them is the CMap Tools software. However, before presenting each conceptual map it is necessary that its author defines whether he/she is working on a semantic decomposition, in which the attributes are, thus, features, or whether he/she is demonstrating semantic networks in which the attributes constitute hierarchical relations among conceptual units. These two types of representation may be, nevertheless, naturally mixed and there should be a sort of formal mechanism in this software that allowed the passage of a kind of representation to another.

It is also important to define **properties heritage** among different category levels, viewed throughout hierarchical relations as "it is one" that allowed to "virtually" add certain pairs of value-attributes from a unit to another. Thus, the *sparrow* may inherit the *property of flying* because it is a kind of *bird*. We should also think of concepts managing that, in a given category, are considered as an exception. If we define the ostrich as a kind of *bird*, we need to indicate, in an explicit manner, that despite the ostrich is defined as a bird it does not inherit the *property of flying*. The property of flying, that could be a value *par défaut,* would need, then, explicit information to contradict it. It would be necessary that the software allowed the **heritage blockage** of certain attributes. The circle has closed and we come back, then, to the beginning of this text, which deals with prototypes and stereotypes whose basis is the concepts representation from the heritage *par défaut* that allows a great economy in the acquisition and managing of the information. These are just some suggestions.

At the moment we are performing the second phase of this research, comparing the maps that present ideological similarity and those that are divergent and present a "cognitive deviation" (Cordier, 1989). We believe to be opening new perspectives to the study of ideological similarity perception as a way to facilitate the collaborative creation of concepts mediated by computer, both in traditional and distance learning.

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