Concept Maps: Theory, Methodology, Technology
Proc. of the Fifth Int. Conference on Concept Mapping
Valletta, Malta 2012

MASTERY AND APPROPRIATION OF CONCEPT MAPPING IN HIGHER EDUCATION

Lilia Susana Domínguez-Marrufo, Jesús Manzano-Caudillo
Universidad Autónoma del Estado de Morelos, México
lsdm9121@hotmail.com

Abstract. It is the purpose of this paper to explain the difficulties that higher education students confront when constructing concept maps from academic texts readings. To this effect, interviews with 15 participants at the college level were analyzed and the resulting concept maps that they produced throughout a six-month school term were analyzed as a tool that can be used to understand textbooks. The sociocultural perspective, with conceptualizations such as mediated action which includes aspects of mastery and appropriation, resistance, and multiplicity of objectives (Wertsch, 1998), turns out to be useful to understand the functions that concept mapping performs as a cultural tool in learning mediation as well as to understand the deficiencies in constructing a concept map.

1 Introduction

The concept map is being the topic of discussion in different scientific communities these days. Its widespread use and dissemination have allowed it to reach a level of stability which, beyond merely being a technique, has become the subject of research. Analytically, it is possible to make a distinction between concept mapping theory and its technique (Aguilar Tamayo, 2004, 2006b). In other words, one can learn to construct a concept map without knowing the theory that lies behind it. This distinction allows for it to be considered a subject of research form other theoretical perspectives that will help explain in this case some difficulties that individuals are confronted with at the time of constructing them. In its *Theory of Education* (1982), Novak had already identified some concepts derived from the sociocultural theory, such as *word and language*, to highlight its importance in the formation of scientific concepts. He has more recently recognized the usefulness of other conceptualizations by Vygotski on *collaborative work* and *the Zone of Proximal Development* (ZPD) to guide his formulations on new educational facts (Aguilar Tamayo and Aguilar García, 2008).

This paper seeks to set forth elements to reflect on why higher education students find it difficult to build concept maps from a reading comprehension exercise. In order to understand how and why the different cultural artifacts are –or are not– used, one can take a look at the sociocultural perspective, from where a concept map is conceived as a mediated action, which can be understood as a dialectic action between agent and agengy (Wertsch, 1998). The concepts of mastery and appropriation inherent to mediated action might be useful to understand some difficulties present when building concept maps, particularly that one which is built from the reading of scientific texts. Some of these problems have already been reported in past works (Acuña, Aguilar Tamayo, and Manzano C., 2010; Aguilar Tamayo, García, Cuenca, and Montero, 2006; Manzano C., 2010; Manzano C., Aguilar Tamayo, Sánchez Valenzuela, and Alvarado Vázquez, 2010).

2 Difficulties in constructing a concept map

Constructing concept maps from one reading can be used both as an assessment tool (Anderson and Huang, 1989; Hay, 2007; Rice, Ryan and Samson, 1998) as well as a comprehension tool (Chang, Sung, and Chen, 2002; Hilbert and Renkl, 2008; Iraizoz Sanzol and Gonzalez García, 2006; Liu, Chen, and Chang, 2010). However, students who have just begun working on them may exhibit problems of various types; for example, cognitive overload (Chang, et al., 2002; Reader and Hammond, 1994), which prevents them from taking full advantage of semiotic mediation afforded by concept mapping. Other difficulties in its construction have to do either with the totality of previous knowledge that students may have on a specific domain of knowledge, or with their level of reading comprehension (Acuña, Aguilar Tamayo, and Manzano C., 2010). Difficulties have also been reported in the construction of a concept map when it has been utilized to interpret a text or as an ancillary tool in the presentation of a topic. For instance, a tendency has been identified to build and read conceptual maps from left to right –such as it is done in the alphabetical culture of the West– as the principle of hierarchical organization is left aside. It has also been observed that in its creation, a certain order is followed in the narrative or argumentative structure. Similarly, there are cases where no complete conceptualization is achieved, as students create their concept map from the first four or five pages of a text, or maybe there is no focus question due to the fact that some word from the title is reintroduced and placed as main concept (Aguilar Tamayo, et al., 2006).

Other studies report fruitless educational experiences in the implementation of concept maps as a didactic strategy. Moreover, a deficient construction is identified in such studies together with certain resistance strategies linked both to memoristic learning and to strategies to get credit for courses. In such experiences, while most students appear to acknowledge the fact that concept maps are a learning tool, they consider it difficult to get rid of the strategies that have worked well for them and allowed them to pass their courses. They are *used to summarizing* from 'reading, identifying fragments that look relevant and literally copying them' (Manzano C., et al., 2010, p. 257). Their rejection and resistance towards concept mapping could also be attributed to the fact that doing maps entails activities that are more complex than merely carrying out a *procedure*, and that call for the development of a *set of skills* (Moon et al., 2011).

The construction of concepts maps from a text requires the use of multiple simultaneous goals. This helps to understand why students exhibit difficulties when constructing them, as the cognitive processes involved in their learning –when associated with other objectives of the context where the activity is inserted– make their *mastery and appropriation* difficult (Wertsch, 1998). This overlapping of tasks results in a *cognitive overload* for the student (Chang, et al., 2002; Reader and Hammond, 1994); in such a case, the number of complex processes that the creation of the concept map requires undermines an ideal learning. In this work, those students who exhibited this difficulty report that the readings were 'complicated, difficult, and long.' Thus, it can be inferred that the reading comprehension was already a problem to which the task of learning to build concept maps to reflect their understanding of the text was added. That said, they found it difficult to match the contents of the assignment with the didactic tool, the aim of which was to favor reading, learning, and the representation of both.

All of the above alerts us as to how necessary and important it is to reflect on a *didactic method for concept mapping* (Aguilar Tamayo, 2006). In addition to the comprehension reading aspect, such didactic method must take into account the formative deficiencies of teachers, especially with regard to higher education; otherwise, any complex learning that might be supported by the concept map strategy will be displaced by those practices that reintroduce resistance and simulation (Manzano C., et al., 2010).

3 Mediated action and the concept map

As it was mentioned, this paper provides elements to re-conceptualize the concept map from the sociocultural perspective, that is, as a cultural tool that mediates learning within the concept of educational practices. Aguilar Tamayo (2006a; Aguilar Tamayo and Aguilar García, 2008) suggests that *ZPD* concepts and the idea of cultural *tool* or *artifact* may serve as a guide to attain said approximation. The *ZPD* concept developed by Vygotski helps to understand the construction processes of meanings as well as the mediation that is done in this zone through the *accompaniment* and the function of *expert structure* as semiotic interventions made up by human agents or artifacts that intervene as learning mediators. The concept map thus performs the function of mediator (Aguilar Tamayo, 2003).

In this order of ideas, Wertsch (1998), upon analyzing human action, resorts to Burke's Dramatistic Method (1975), also known as *pentad*, which consists of: a) act, b) scene, c) agent, d) agency, and e) purpose, to describe, interpret, or explain human action[1] somehow opposed to phenomena like conduct, attitudes, or psychic or linguistic structures. Wertsch reintroduces the *agent* and the *agency* from Burkes's model as core elements of his understanding of *mediated action* and affirms that all the other elements of the pentad are integrated in the agent-agengy dialectic on the grounds that virtually all human action involves mediated action that is always centered on the agent and its cultural tools, which are invariably situated within a historical, institutional, and cultural context. The *agent* is the one who performs the act and the *agency* the means or the instruments used by the agent in the performance of the act, in other words, the cultural tool. By the same token, the mediated action and the cultural tools exhibit certain characteristics that will eventually give form to their expression. For the purpose of this paper, we will reintroduce mainly those belonging to *mastery and appropriation*.

Mastery implies "knowing how" to utilize a form of mediation with ease. (Ryle, 1949, cited in Wertsch, 1998, p. 87). A greater *mastery* of the cultural tool would result in positive *appropriation*. However, this is not always the case. One can master a tool without appropriating it, as the *appropriation* always implies resistance in some way. This is the rule rather than the exception. Besides, the *appropriation* is directly

[1] Human action as basic analysis phenomenon has previously been studied by Vygotsky (1978, 1981,1987), Bakhtin (1981) and Mead (1934), all of them cited in Wertsch (1998, p. 32)

related to some spontaneous, creative, and free use in different spaces and scenarios, as Moon (2011, p.44) states in its metaphor "when you have a hammer, everything looks like a nail." On some occasions, the resistance may turn into rejection. In extreme cases, those where the agent is forced to use the tool, one resorts to simulation strategies.

Pursuant to the concept map, we can affirm that one has mastered the technique of concept mapping when: a) it is constructed from a focus question; b) there is hierarchization; c) no concepts are repeated, nor are there verbs serving as concepts or vice-versa; d) it has more than four arms or branches; e) there are cross links[2] and, f) it comprises 35 to 40 concepts (Moon, et al., 2011, Domínguez-Marrufo, 2009). Evidence that the student has appropriated the concept map is when she uses it in other fields and activities on her own initiative. There could be *mastery* without *appropriation*, though not *appropriation* without *mastery*.

4 Methodology

4.1 Participants and design

Fifteen college-level students participated in the study. They were enrolled in the fourth semester (core courses) of the General Didactics program leading to a Sciences of Education and Teaching degree in a public university located in southern Mexico. The concept maps collected were the product of readings (eight texts) from the course's basic bibliography. Moreover, the students were interviewed to find out more about their ideas and knowledge on concept mapping and the CmapTools (Cañas et al, 2004) program.

The didactic model that guided the implementation of the concept map was configured through five stages: a) introduction to the concept map and to the CmapTools program by the teacher; b) construction of a concept map by the student after reading the text in order to submit it and share it through CmapTools; c) review of the concept map by the teacher (as many times as was deemed necessary) and suggestions for improvement; d) correction and re-construction of the concept map by the student and; e) collection of the initial and final concept map for each reading in an evidential digital file at Cmap Tools' CmapServer. In addition to the group analysis of the readings, the activity with concept maps carried out through the school term incorporated peer review, and practices in collaborative work. In class, half the time was dedicated to the construction of concept maps in the computer classroom. This not only facilitated the use and practice of the CmapTools program – especially for those students that had no computer– but also guaranteed the constant monitoring of conceptual map creation by the teacher.

Before the school term was over, the participating students were interviewed. The interviews were semi-structured, designed to be completed in about 30 minutes, and they were intended to make a contrast between the understanding one already has of the concept map and the already-formulated concept maps. One more goal was to find out more about learning and the contents of the course.

4.2 Data analysis method:

Data were analyzed qualitatively. In order to evaluate the concept maps, the Rubric to evaluate concept maps created from reading comprehension was used (Domínguez-Marrufo, 2009).[3] In the selection of the concept maps to be evaluated through the Rubric, it was decided to choose first the most recent reconstructions of concepts maps, and second, to choose the practice of the concept map that was done throughout the semester in order to identify the different stages of the learning of the technique (See Table 1).

It must be added that the points awarded to the concepts maps through the rubric are tallied up to a score through which they can be identified as *good, average,* or *deficient.* A good concept map garners upwards of 60 points, average conceptual maps carry between 33 and 60 points and deficient maps are below 33 points.[4]

Table 1. Selection of concept maps to be evaluated through the Rubric

[2] Elements that are reintroduced from the scoring system for Novak's concept maps (Novak and Gowin, 1988)

[3] The rubric evaluates the following dimensions: a) focus question and main concept, b) subordinate questions, c) links and propositions, d) cross links and e) hierarchy. The rubric identifies three levels of performance based on significant learning, which show the learning achieved by the students in the construction of the map.

[4] According to the category outlined in the rubric (see previous footnote), the numerical values assigned to each category vary in function of its importance in relation with the construction of a concept map (Domínguez-Marrufo, 2009).

Moment when the technique is learned	Moment when the learning of the technique begins	Moment when the technique was learned (stability)	Moment when the technique is perfected and signs of creativity
Text chosen from the basic bibliography	Text 1	Text 5	Most recently read text (it could have been 6, 7 or 8)
Denomination	Initial concept map	Intermediate concept map	Final concept map
Construction	Last reconstruction	Last reconstruction	Last reconstruction

Table 1. The selection of the maps to be evaluated through the rubric is described in accordance with the moment of learning of the technique as well as with the mapped text.

The interviews were analyzed under the following categories: attitude and readiness to construct concept maps, number of reviews and concept map reconstruction, use of concept maps in other areas, ease/difficulty to construct concept maps, ease/difficulty in the reading comprehension, utilization of other techniques and learning strategies, learning of didactic and CmapTools material. This information was contrasted with the students' concept maps.

5 Results and Discussions

It must be pointed out that even though the student's discourse can be viewed as a cultural tool, for the purpose of this paper such discourse is considered merely as part of the scene. The students' discourse on the use of the concept map and the concept maps that they construct help to identify whether there is *mastery* and/or *appropriation* of the cultural tool, which helps to explain, partly, the difficulties that students encounter when constructing them. Still other aspects that may as well help us to understand why the student is unable to construct good concept maps is the one called *illusion of knowing*[5] (or of comprehension) and cognitive overload, which results from the quantity and quality of activities performed towards the construction of a concept map.

Pursuant to the interviews analyzed, although the questions were made at different times of the interview, they are shown in a continuous manner due to space constrains, and ellipsis dots (…) were used to show a break in the continuity. Finally, it must be pointed out that care was taken at all times to maintain the original sense and meaning of the student's discourse.

In terms of *mastery* and *appropriation*, the following examples illustrate the concept map:

Interview with Agustina

E: Did you like using concept maps?
R: Yes, a lot. As I was saying, I was one of those who focused just on reading, I never highlighted the concepts, concepts maps kind of helped me to get more out of it. While in the past I understood 50%, now I understand a little more, 60%, with the help of concept maps. (…)
E: What is a concept map?
R: Well, it is a tool that facilitates reading comprehension…that facilitates reading.
E: OK. Have you at some point used concept maps in other courses?
R: No. So far I haven't.

It can be posited that Agustina has somehow mastered concept mapping as her first map earned her a good score (57 points); by contrast, on her last map she obtained a rather poor score (33 points). This would indicate either that she has not reached full mastery of the technique, or that she is finding the reading difficult, in other words, that the text proved difficult for her to understand, and not necessarily that she was unable to construct a concept map. With regard to appropriation, one can say that no mastery was accomplished: although Agustina did realize that concept maps have enabled her to "understand a little bit more," she also admits not using it in other courses, in other words, she has not *made it hers*.

Interview with Brenda

E: About the General Didactics course, what can you tell me about your experience with concept maps?

[5] Illusion of knowing (Commmander and Stanwick, 1997) is associated with a deficit in monitoring reading that triggers failures in comprehension and undermines learning. It arises when the level of reading is elementary: where one can relate what the text says, but one cannot interpret, infer, or learn with and from the text.

R: Uh, for me, it is a good alternative because it is another tool you can use at work, at school, or with any other exercise in general. Using concept maps provided me with a good alternative to do things differently from what I was doing, like underlining and reflecting…and that was just about it. Concept maps have enabled me to accomplish more, some sort of a more tangible work where I can link them up and connect them, which will lead to some analysis, some reasoning, but with some basis to support me any time I want.
E: Did you like using concept maps?
R: Yes, like I said, I was already using this program. I already knew it, and that was it, I knew it superficially but not really in detail. Creating a concept map totally changes your perspective when someone tells you how to use it, to simply know that it is there for you whenever you need it. (…)

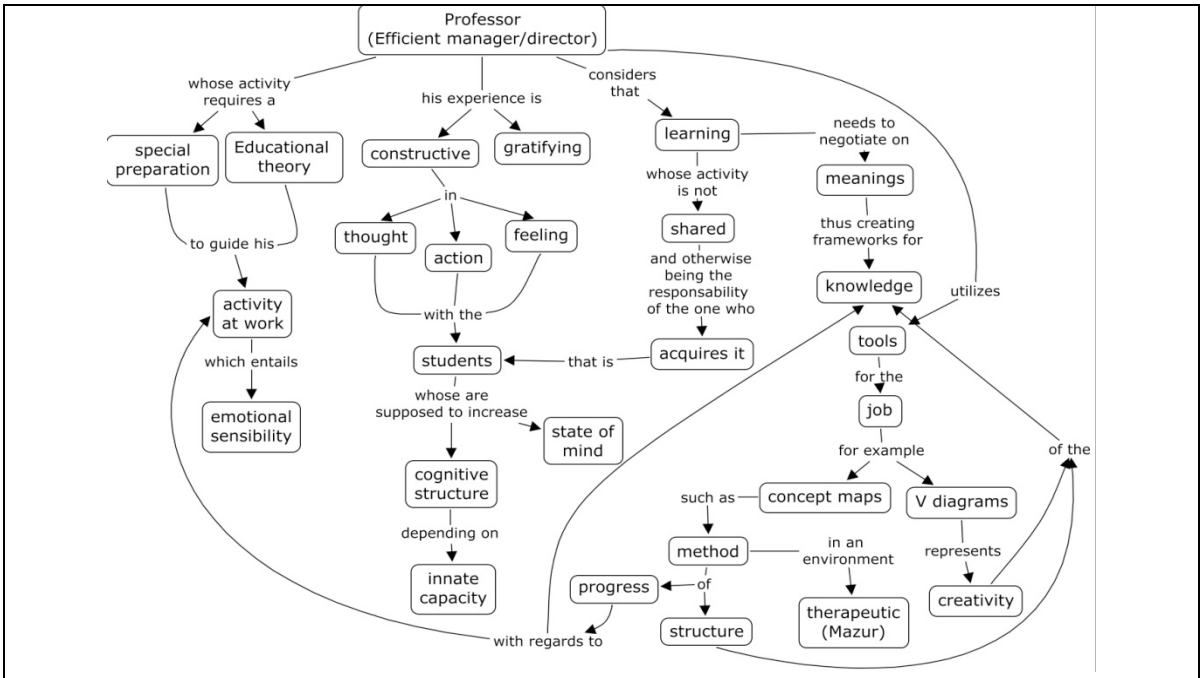

Chart 1. Most recent concept map constructed by Brenda (with a score of 54). This concept map shows that no sentences are used as concepts. A good hierarchization and cross links can be observed.

Brenda turned in good concept maps (with scores above 60), thus demonstrating good mastery of the tool and a good reading comprehension. Compared with Agustina, Brenda engages in a more elaborate discourse, understands concept mapping as a tool to understand texts, and has used it in other courses on her own initiative, proof that she has *appropriated* the map.

On the subject of the multiplicity of simultaneous goals inherent in mediated action –which also helps to explain the difficulty one encounters when constructing a concept map– it can be posited that the task of learning the contents of didactics and the use of cognitive resources needed in reading comprehension interfered with the task of learning the concept map technique and with the way it is used in guiding, understanding, and representing said reading comprehension. Following are some examples:

Interview with Alexis

E: Do you think you understood the most important aspects?
R: Well, yes. I did understand the most important aspects, but still there is this lag, like there was a *bunch* of information, yes it is the information, but for us, that is really not the idea, like cut and dried, that we have to read and read and… I mean, it is like we do not totally understand the first part; there is a *bunch* of information that maybe we don't run through all. (…)
E: What elements did you like the least?
R: That in order to reason you have to read over and over again, I mean in order to grasp the basic concepts. (…)
E: What elements did you find the most difficult?
R: The most difficult? The final parts, the key words of the diagram; as it moved from the top down; to place the least important concepts, you do one reading and it's like you find everything important right away, that is my real problem. (…)

Alexis obtained poor scores on both the intermediate and final maps (13 points on each). These scores seems to have a direct relationship with *the bunch of information to be read over and over again in order to grasp the basic concepts.* It seems that identifying the hierarchy was the greatest difficulty for Alexis as he mentions that he found it hard to assign a hierarchy to the reading concepts on the grounds that all of them seemed to have the same weight. It can be said that Alexis found himself facing the choice between understanding the reading and constructing a good concept map.

Still another type of difficulty that we encountered when doing concept maps was what we referred to above as illusion of knowing (Commander and Stanwyck, 2007). In this case, the students declared that they learned the technique involving concept maps and the contents of General Didactics, and that they are even satisfied and happy that they *learned* to use the conceptual map; however, their concept maps demonstrate the opposite, as evidenced by the following interview:

Interview with María Elena

E: Do you use any other technique or tool?
R: Not anymore. Before I would use the comparative tables, synoptic tables, mind maps…
E: What do you mean by 'not anymore'?
R: I mean we kind of lean more towards constructing concept maps, it's like the technique…I found it a little easier…easier to do maybe.
E: Regarding the General Didactics course… How did you find the experience of using conceptual maps?
R: I think it was alright because we kind of learnt more about the work that needs to be done to create a concept map, like trying to do it the right way.
E: Also, about this Didactics course, do you think that you understood the main points of the course?
R: Maybe not 100%, but I did grasp the basics of the course.
E: Did you like using concept maps? **R:** Yes, I did (…)
E: I mean, were there any other courses where you used the maps on your own initiative? (…)
R: Yes. I used them in Psycho-pedagogical Problems in Learning. (…)
E: What do you like best about concept maps?
R: That at any time that I get the chance to go back I will find a map that I have done, I can look at it again, and maybe remember, just by looking at the way I organized it, what topic it is about.
E: Are you thinking of continuing to use them? **R:** Yes.
E: Why?
R: Because it is a very easy to understand the texts that way.

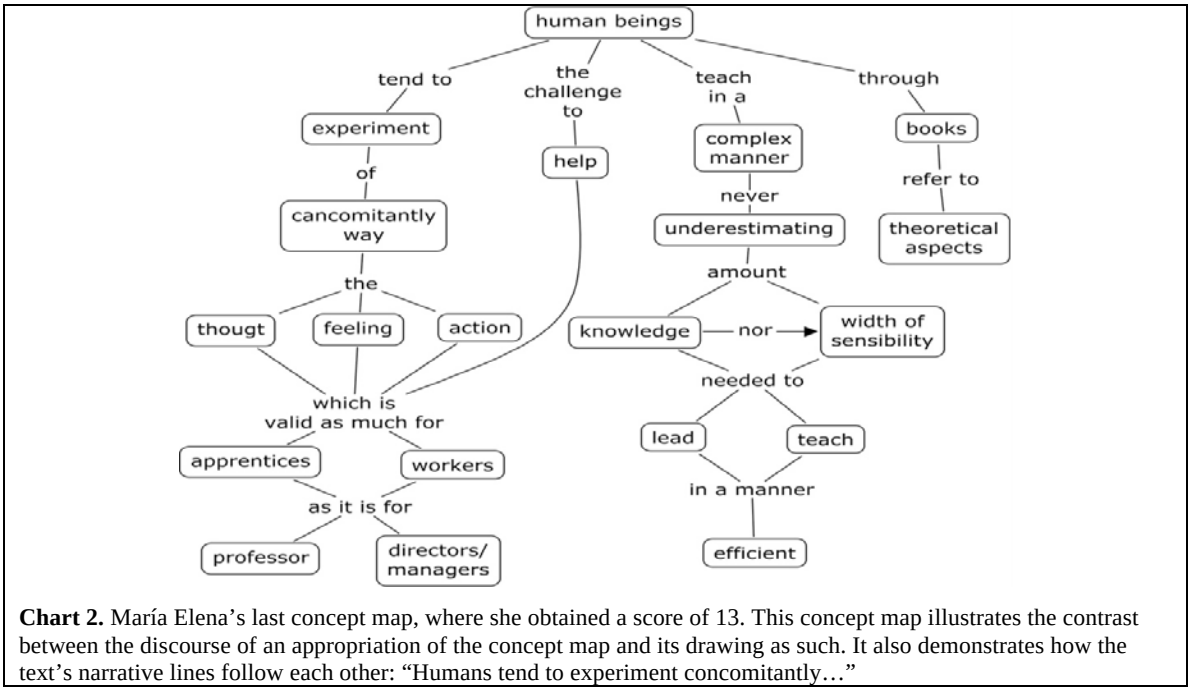

Chart 2. María Elena's last concept map, where she obtained a score of 13. This concept map illustrates the contrast between the discourse of an appropriation of the concept map and its drawing as such. It also demonstrates how the text's narrative lines follow each other: "Humans tend to experiment concomitantly…"

In Maria Elena's case, her discourse seems to demonstrate the appropriation of the concept map. She mentions that she found concept mapping easier, that she liked using them, that she learned at least the basics from the contents of Didactics and that she has used them in other courses. However, her concept maps were

deficient: there were no significant changes in subsequent drawings and higher scores were reported on the first ones as compared with the final ones (35, 33 and 13 points respectively), which may indicate a lack of *mastery*. When asked what part she liked best, she answered that *when she finds a map that she has done she will perhaps remember the way she organized it*. This leads us to infer that after this course she has no intention of continuing to use concept maps, while also suggesting that there is no *appropriation.*

6 Conclusions

The cases depicted in this work –as well as several others which were not included by reason of space– are associated with difficulties in reading comprehension and with the fact that the learning of the concept map technique was not understood as a tool intended to guide reading, nor was it meant to understand or represent the acquired knowledge. Instead it was viewed as more material to be learnt during the Didactics course. At the same time, this made reading –as well as the mastery and appropriation of the technique– more difficult. A concept map that results from reading is not a tool that can be easily mastered. Building a concept map is not only a procedure, it entails the use of a set of cognitive, metacognitive, and self-regulatory skills, among them the automatization of reading, the possession of strategies for reading comprehension and for learning and, finally, the determination to learn extensively. The contents of these interviews give us elements to reflect on the students' learning practices because the decision to learn the concept map technique –and learn through it– is undermined by traditionalistic pedagogical models that still persist in higher education, such as the practice to learn through memorization and through the repetition of contents without any meaning or sense whatsoever, albeit effective to pass courses. It is necessary to reconsider the need to design a didactic of the concept map –at least in the domain of the social sciences– that takes into consideration the problems set forth.

7 References

Acuña, S. R., Aguilar Tamayo, M. F., and Manzano C., J. (2010). Efectos de un apoyo mediacional en tareas de elaboración de mapas conceptuales en estudiantes universitarios con diferentes niveles de habilidades lectoras. In J. Sánchez, A. J. Cañas and J. D. Novak (Eds.), Concept Maps: Making Learning Meaningful. Proceedings of the Fourth Conference on Concept Mapping (Vol. 1, pp. 188-195). Viña del Mar: Universidad de Chile.

Aguilar Tamayo, M. F. (2004). El mapa conceptual: un texto a interpretar. In A. J. Cañas, J. D. Novak and J. M. González (Eds.), Concept Maps: Theory, Methodology, Technology. Proccedings of the First International Conference on Concept Mapping. Vol. 1 (Vol. 1, pp. 31-38). Pamplona, España: Universidad Pública de Navarra.

Aguilar Tamayo, M. F. (2006a). El mapa conceptual y la teoría sociocultural. In A. J. Cañas and J. D. Novak (Eds.), Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping (Vol. 1, pp. 216-223). San Jose, Costa Rica: Universidad de Costa Rica.

Aguilar Tamayo, M. F. (2006b). Origen y destino del mapa conceptual. Apuntes para una teoría del mapa conceptual. In A. J. Cañas y J. D. Novak (Eds.), Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping (Vol. 1). San José de Costa Rica: Universidad de Costa Rica.

Aguilar Tamayo, M. F., García, O., Cuenca, I., and Montero, V. (2006). La escritura y lectura de los mapas conceptuales en los alumnos de educación superior. In A. J. Cañas and J. D. Novak (Eds.), Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping (Vol. 1). San José, Costa Rica: Universidad de Costa Rica.

Aguilar Tamayo, M. F., and Aguilar García, M. F. (2008). Novak and Vygotsky and the Representation of Scientific Concept. Paper presented at the Concept Mapping: Connecting Educators Proc. of the Third Int. Conference on Concept Mapping, Tallin, Estonia and Helsinki, Finlandia, 1.

Bajtin, M. M. (1981), *The dialogic imagination: Four essays by M. M. Bakhtin*. Ed. M. Holquist. Austin: University of Texas Press.

Burke, K. (1975). Dramatismo. In D. L. Sills (Ed.), Enciclopedia Internacional de las Ciencias Sociales (Vol. 6, pp. 180-185). Madrid: Aguilar.

Cañas, A. J., Hill, G., Carff, R., Suri, N., Lott, J., Eskridge, T., et al. (2004). CmapTools: A Knowledge Modeling and Sharing Environment. In A. J. Cañas, J. D. Novak & F. M. González (Eds.), *Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept Mapping* (Vol. I, pp. 125-133). Pamplona, Spain: Universidad Pública de Navarra.

Chang, K.-E., Sung, Y.-T., and Chen, I.-D. (2002). The Effect of Concept Mapping to Enhance Text Comprehension and Summarization. [Article]. Journal of Experimental Education, 71 (1), 5.

Dominguez.-Marrufo, L. S. (2009). Rúbrica y puntaje del mapa conceptual. Una propuesta para la evaluación de mapas conceptuales en la educación superior. Tesis sin publicar, Maestría, Universidad Autónoma del Estado de Morelos, Cuernavaca.

Evans, N. & Stanwyck, D. (1887). Illusion of Knowing in Adult Readers: Effects of Reading Skill and Passage Lenght. Contemporary Educational Psychology No. 22, 39-52.

Hilbert, T. S., and Renkl, A. (2008). Concept mapping as a follow-up strategy to learn from texts: what characterizes good and poor mappers? Instructional Science, 36, 53-73.

Iraizoz Sanzol, N., and Gonzalez García, F. M. (2006). El mapa conceptual (MC): un instrumneto idóneo para facilitar la comprensión lectora. In A. J. Cañas, J. D. Novak and F. M. González (Eds.), Concept Maps: Theory, Methodology, Technology. Proceedings of the Second International Conference on Concept Mapping (Vol. 1, pp. 216-223). San José, Costa Rica: Universidad de Costa Rica.

Liu, P.-L., Chen, C.-J., and Chang, Y.-J. (2010). Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension. Computers and Education, 54, 436-445.

Manzano C., J. (2010). El uso del mapa conceptual en la comprensión de textos. Estudio de caso en alumnos de educación superior. Tesis sin publicar, Maestría, Universidad Autónoma del Estado de Morelos, Cuernavaca.

Manzano C., J., Aguilar Tamayo, M. F., Sánchez Valenzuela, M. M., and Alvarado Vázquez, I. (2010). ¡Yo no quiero hacer mapas conceptuales! Estrategias de resistencia de los alumnos universitarios en la apropiación de la herramienta. In J. Sánchez, A. J. Cañas and J. D. Novak (Eds.), Concept Maps: Making Learning Meaningful. Proceedings of Fourth International Conference on Concept Mapping (Vol. 2, pp. 254-258). Santiago de Chile: Universidad de Chile.

Mead, G. H. (1934), *Mind, self and society from the standpoint of a social behaviorist.* Chicago: University of Chicago Press.

Moon, B. M., Hoffman, R., R. , Eskridge, T. C., and Coffey, J. W. (2011). Skills in Applied Concept Mapping. In B. M. Moon, R. R. Hoffman, J. D. Novak and A. J. Cañas (Eds.), Applied Concept Mapping: Capturing, Analyzing, and Organizing Knowledge (pp. 23-46). Baton Rouge, FL: CRC Press.

Novak, J. D., and Gowin, D. B. (1988). Aprendiendo a aprender. Barcelona: Martínez Roca.

Reader, W., and Hammond, N. (1994). Compute-based tools to support learning from hypertext: Concept mapping tools and beyond. Computers and Education, 12, 99-106.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Ed. M. Cole, V. John-Steiner, S. Scribner and E. Souberman. Cambridge, Mass.: Harvard University Press.

Vygotsky, L. S. (1987). *The collected works of L. S. Vygotsky: Vol. 1. Problems of general psychology*. Nueva York: Plenum.

Wertsch, J. V. (1998). La mente en acción. Buenos Aires: Aique Grupo Editor.