

## NOVAK AND VYGOTSKY AND THE REPRESENTATION OF THE SCIENTIFIC CONCEPT

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**Abstract.** Vygotsky gives a theory for the scientific concept formation and the process within are constructed the meanings, that theory is suggestive to establish a relation with the concept map and the way this one, represents the relation between concepts. The similarity between the Vygotsky's linguistic metaphor and the Novak's visual-spatial metaphor is more than a coincidence. In this paper are analyzed the Novak and Vygotsky's perspectives about the scientific concept with two purposes. One goal is the introduction of conceptual elements of the sociocultural theory that could help to understand the semiotic functions of the concept map within the context of the educational practices and learning processes. Other purpose is the redescription of the concept map in terms of cultural psychology for the reason that the concept map will useful to the study of concept formation and the understanding of the verbal thinking.

### 1 Introduction

The concept map could be used for mediate and facilitate the scientific concept learning, there are several ways to help the learning process and depends on the activity system witch is part the concept map. The activities could be realized by individuals, in collaboration between pairs or in groups, with or with out the teacher guidance, among other possibilities (Novak & Gowin, 1984; Novak, 1998). The research had demonstrated the efficacy of concept map to help the scientific concept learning (Novak & Musonda, 1991; Novak, 1998, 2002), most of research had used Ausubel's learning theory (Ausubel, 2002) and the Novak's theory of education (Novak, 1982, 1998; Novak & Gowin, 1988).

A previous paper had contributed analyzing the concept map as *cultural artifact* and their semiotic function that make of it a mediational mean for the learning (Aguilar Tamayo, 2006a). This paper will be analyzed in Vygotsky's perspective the concept of *scientific concept*, and the concept map will be used as a metaphor to understand some of the aspects of the Vygotsky's perspective. This analysis pretend to be useful for the understanding of Vygotsky's theory, and to make visible the concept map inside the sociocultural theory, this implies a reconstruction of the concept map as a research object it self, along with contributing to a *theory of concept map* (Aguilar Tamayo, 2005, 2006b, 2006a).

### 2 The concept

The concepts are mental representations that allow to the individual recognize and categorize events and objects. The externalization of the mental representation needs symbols like the words, signals or draws among others. Novak (1998) consider the *word* as a *label* that represents the concept. The mental representation can be named using words and communicated trough the language.

Taking in example the word *chair*, this one had a variety of referents; the label of *chair* can be referred to a particular object or a group of things with function and characteristics that make them similar or in the same category. The concepts are generalizations elaborated from events, objects or other concepts. The concept's label, in Novak perspective, is the word, and for Vygotsky, the word, is a *means for concept formation* (Vygotski, 2001 p. 126). The externalization of the concept happen trough the word, or said it with more accuracy, trough the language.

The concept is the *word meaning* (Fodor, 1999. p. 19) that is the unit of analysis for the understanding of verbal thinking (Vygotsky, 1987 p. 46). The construction of the meaning is a generalization process (Vygotsky, 1987 p. 47), process that is implies the creation of the relation between concepts, the meaning not only depend on the material referent (objects, material reality), as well depend on other concepts.

Pozo (1994) considerer authors like J. Piaget, D. Ausubel and L. S. Vygotsky with a common theoretical perspective: *theories of re-structuring*. A common issue is the interest about the concept learning and the study of concept formation (Pozo, 1994. p. 168), other similarity is the difference that the authors make between every day concepts and scientific concepts.

Pozo (19984, p. 215) founds in the meaningful learning theory some aspects that Vygotsky never get develop. Even Vygotsky describes the concept formation process, and the social and cultural context where this

happen, he not presents a specific educational proposal to help the concept formation; this is quite different with Ausubel (2002) and Novak (1982; 1998, Novak y Gowin, 1988), this authors suggest instructional strategies to help the concept learning. However, Vygotsky did mention the concept formation take place when the learner participates in a goal directed activity that implies demand for the learner (Vygotski, 2001 p. 123).

Ausubel and Vygotsky both recognize the relevance of previous knowledge for the formation or acquisition of new concepts (Vygotski, 2001 p. 195; Ausubel, 2002 p. 40) and the significance of the instruction for the concept leaning. They agree that the process of subordination-generalization is part of the learning of scientific concepts (Pozo, 1994 p. 220; Vygotski, 2001 p. 215; Ausubel, 2002 p. 261). Novak, Ausubel and Vygotsky criticized the rote learning (Novak, 1998 p. 154-155; Ausubel, 2002 p. 32; Vygotski, 2001 p. 185)

Using the Ausubel's theory, Novak conceives the concept map technique. This technique allow the propositional and conceptual structures representations, trough this, Novak analyzed the human cognitive structure and the same time Novak creates a visual-spatial representation with other characteristics. Ausubel, Novak and Vygotsky shares a metaphor; the net of concepts and the organized and hierarchical structures, metaphors that are represented on the concept map.

### **3 Every day concept and the scientific concept**

For Vygotsky (2001) the formation of the scientific concept requires that the learner participates within a specific environment designed for that purpose; the scientific concept is learned within formal education. The every day concept could be formed as result of casual communicative interactions, or social and cultural organized interaction associated to concrete experiences.

Vygotsky discriminate the external structure of the word from the internal one. The external structure of the word depends on the relations with objects and the uses in social and cultural context, because that, the structure of the meaning is not related to a symbolic structure (Vygotski, 2001 p. 114). In the case of the child, the word meaning is given as results of the communication process with adults (Vygotski, 2001 p. 150). In the formal process of communication, for instance the instruction in classroom, the word meaning is given for a net of concepts and their relation are related to a knowledge domain or scientific discourse. The internal structure of the word is a symbolic structure where the concepts are means for the construction of new meanings, making new relation with new concepts or reorganizing the concepts, according with Vygotsky, this processes is an act of thinking (Vygotski, 2001 p. 184) mediated by meaning or by the concepts (Vygotski, 2001 p. 342).

In Vygotskian terms the concept map is a symbolic system that allow to the human, within the elaboration process, explore the meaning of the word, or could said to, the concept elaboration. The concept map is a method for the exteriorization of the human representation, helps to get ahead of the external structure of the word constructing relation between concepts, this require the generalization processes, a dynamic process of making meaning, using concepts to give meaning to others concepts.

### **4 Metaphors and representations of the concept map and the scientific concept**

The concept map is a representation as well a metaphor of the conceptual structure from a knowledge domain. The concept map is a representation of the human cognitive structure, the elaboration process of the concept map helps to make visible the previous cognitive structures and, if the activities demand it, developing new cognitive structures.

Is not possible in this paper present in more detailed way the Vygotsky's theory of concept formation, even so, is possible and relevant to clarify that for Vygotsky, the genuine concept is the scientific concept, the every day concept is a pseudo-concept because the origin and function in thinking (Vygotski, 2001 p. 251). The data at Vygotsky's time indicate the scientific concept formation take place until the puberty or adolescent age, between 12 y 14 year old. Considering this, the child have not arises a development enough to conceptual thinking. However, contemporary research mentioned by Pozo (1994) and original research by Novak (Novak y Musonda, 1991) indicated learning of scientific concept could be more early that Vygotsky's suppositions.

Even Vygotsky not considered possible the conceptual think in child, the author make clear that many of the pseudo-conceptual thinking are essential to develop the conceptual thinking. The every day concept are a

case of pseudo-concept, their function and structure make them a pseudo-concept and not a *genuine concept* but they are important for the acquisition or scientific concepts (Vygotski, 2001 p. 164, 251)

The conceptual structure present in a determinate concept map is a representation of a moment or stage of thinking, or a stage within the process. The construction of the meaning is for Vygotsky a dynamic process of generalization. Lines down are quoted Vygotsky's description of this process. Knowing the concept mapping process, the next quote seems fits well to understand it.

[...] Only within a system can the concept acquire conscious awareness and a voluntary nature. Conscious awareness and the presence of a system are synonyms when we are speaking of concepts, just spontaneity, lack of conscious awareness, and the absence of a system are three *different words for designating the nature of the child's concept*.

[...] If conscious awareness means generalization, it is obvious that generalization, in turn, means nothing other than the formation of a higher concept (*Oberbegriff - ubergeordneter Begriff*) in a system of generalization that includes the given concept as a particular case. However, if a higher concept arises above the given concept, there must be several subordinate concepts that include it. Moreover, the relationships of these other subordinate concepts to the given concept must be defined by the system created by the higher concept. If this were not so, the higher concept would not be higher than the given concept. This higher concept presupposes both a hierarchical system and concepts subordinate and systematically related to the given concept. Thus, the generalization of the concept leads to its localization within a definite system of relationships of generality. These relationships are the foundation and the most natural and important connections among concepts. Thus, at one and the same time, generalization implies the conscious awareness and the systematization of concepts (Vygotsky, 1987 p. 191-192; Vygotski, 2001 p. 215)

The generalization is a process of meaning making, uses the concepts to make relations and to create new meanings, some of the outcome are a concept net flexible depending on relation between concept and their subordination could be redefine dynamically, as it happen in the concept mapping process.

## 5 Conclusions

In the perspective of this work the concept map is regard as research object it self, this implies some de-contextualization from the origin a theoretical background, in this way, the concept map is visible for others disciplines and theories, and diversify the analysis, in example, considering the concept map as cultural artifact (see: Aguilar Tamayo, 2006b, 2006a). This kind of analysis do not mean the complete abandon of original theoretical background but allow developing new concept for the interpretation of the concept map and the educational and research practices with it (i. e. Aguilar Tamayo, 2004)

The concept map could be useful, inside the sociocultural psychology, as a method for research de concept learning, the developing of technologies like the CmapTools gives the opportunity for registering elaboration process data and not only the results of the activity. The concept map is an important technique for the research; helps to produce formal representation to interpret, and at the same time provide a method to provoke the process in study, in this case, the concept formation or the learning of scientific concept. For Novak perspective it is obvious the concept map uses in research, the relevant in this paper is the analysis that shows the concept map in other theoretical context, that open new questions and new ways to understand the semiotic function of concept map as Novak itself had placed into discussion (see: Aguilar Tamayo, 2006a)

## 6 Acknowledgements

The paper is part of a research in progress financed by: CONACYT CB-2006-01/60651. Was presented at the CMC2008 financed by: PROMEP/103/07/2674

## References

Aguilar Tamayo, M. F. (2004). El Mapa Conceptual: Un texto a interpretar. In: A. J. Cañas, J. D. Novak y F. M. González (Eds.), *Concept Maps: Theory, Methodology, Technology. Proceedings of the First International Conference on Concept Mapping* (Vol. I, pp. 31-38). España: Universidad Pública de Navarra.

- Aguilar Tamayo, M. F. (2005). *Representaciones visuales-conceptuales del conocimiento y estructura del hipertexto educativo*. Unpublished Doctoral Thesis, Universidad Autónoma del Estado de Morelos, Cuernavaca, México.
- Aguilar Tamayo, M. F. (2006a). El mapa conceptual y la teoría sociocultural. 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, pp. 216-223). San José, 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. I, pp. 461-468). San José, Costa Rica: Universidad de Costa Rica.
- Ausubel, D. P. (2002). *Adquisición y retención del conocimiento. Una perspectiva cognitiva*. España: Paidós.
- Fodor, J. A. (1999). *Conceptos. Donde la ciencia cognitiva se equivocó*. España: Gedisa.
- John-Steiner, V. & Mahn, H. (1996). Sociocultural Approaches to Learning and Development: A Vygotskian Framework. *Educational Psychologist* (31), 191-205.
- Novak, J. D. (1982). *Teoría y práctica de la educación*. España: Alianza.
- Novak, J. D. (1998). *Conocimiento y aprendizaje. Los mapas conceptuales como herramientas facilitadoras para escuelas y empresas*. Madrid: Alianza.
- Novak, J. D. (2002). Meaningful Learning: The Essential Factor for Conceptual Change in Limited or Inappropriate Propositional Hierarchies Leading to Empowerment of Learners. *Science Education*, 4(86), 548-571.
- Novak, J. D. & Gowin, B. D. (1988). *Aprendiendo a aprender*. Barcelona: Martínez Roca.
- Novak, J. D. & Gowin, B. D. (1984). *Learning How to Learn*. USA: Cambridge University Press.
- Novak, J. D. & Musonda, D. (1991). A twelve-year longitudinal study of science concept learning. *American Educational Research Journal*, 28(1), 117-153.
- Pozo, J. I. (1994). *Teorías cognitivas del aprendizaje* (3ra. ed.). España: Morata.
- Vygotsky, L. S. (1979). *El desarrollo de los procesos psicológicos superiores*. Barcelona: Crítica.
- Vygotsky, L. S. (1995). Historia del desarrollo de las funciones psíquicas superiores. En: L. S. Vygotski (Ed.), *Obras escogidas III* (Vol. III, pp. 11-340). España: Aprendizaje Visor.
- Vygotsky, L. S. (2001). Pensamiento y Lenguaje. En: *Obras Escogidas II* (pp. 10-348). España: Antonio Machado Libros.
- Vygotsky, L. S. (1987). Thinking and Speech. En: R. W. Rieber y A. S. Carton (Eds.), *The Collected Works of L. S. Vygotsky. Volume 1. Problems of General Psychology* (Vol. 1, pp. 39-285). USA: Plenum Press.